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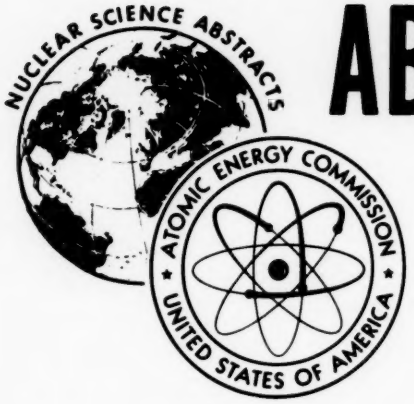

Volume 26 Number 2

Abstracts 1770-4155

January 31, 1972

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NUCLEAR SCIENCE ABSTRACTS

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NEWKIRK, L. R., Superconductivity in the pseudobinary alloys V_3Si—Nb_3Al, 25:1093 (CALT-822-13)
NEWLAND, E. A., Radiation treatment of sewage, 25:140 (AAEC/LIB/Bib-254)

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separation by ion exchange and complex-formation elution, 25:251(P)

TRIETHYLENETETRAMINE
complexes with cobalt(III) and rhodium(III) chlorides, radiation effects on labeled, thermal-neutron, 25:137
TRITIUM
content in Cattaraugus Creek near West Valley Processing Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
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determination in luminescent material by scintillation counting, 25:40 (IDO-12073, pp 28-36)

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372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009-1). Dep. NTIS.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 1986, 1996, 2165, 2191, and 2345.

Chemical and Spectral Procedures

Refer also to abstracts 2208, 2218, 3832, and 3956–3959.

1770 (JUL–772-RW) DETERMINATION OF URANIUM CONCENTRATION PROFILES IN PYROLYTIC GRAPHITE COATED NUCLEAR FUEL PARTICLES. Wallura, E.; Rottmann, J.; Nickel, H.; Gyarmati, E.; van Sinay, R. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Jun 1971. 31p. (In German). Dep. NTIS (U. S. Sales Only).

A method was developed for quantitative determination of uranium traces in pyrocarbon layers of coated particles in the range 10^{-6} to 10^{-9}. At first the layers are mechanically removed stepwise in special glass containers (step-width 5 to 15 μm) in which also the chemical dissolution of the PyC takes place. The uranium is then determined quantitatively by a fluorimetric method, with a relative standard deviation of ±34% for 10^{-9} g, ±6% for 10^{-7} g, and ±4% for 10^{-6} g of uranium. The limit of detection is 10^{-9} g U. Impurities such as thorium, silicic acid, H_2SO_4 coming from the particles or the preparation of the solution do not interfere with the uranium determination. By means of this procedure uranium concentration profiles in the outer layers of coated particles can be determined. For all particles investigated a more or less distinct tub-shaped profile was observed with a maximum near the surface of the outer layers. The concentration level within the coating depends on coating temperature. (auth)

1771 TRACE INORGANICS IN WATER. Symposium Held in Miami Beach, Florida, April 10–13, 1967. Advances in Chemistry Series, No. 73. Washington, D. C.; American Chemical Society (1968). 404p. $12.50. (CONF-670462).

Five papers were indexed separately for NSA. Topics of the remaining papers include: effects of water structure on the transport properties of electrolytes; anions in aqueous solution; some effects of trace inorganics on the ice–water system; aluminum species in water; interaction between aluminum and phosphate in aqueous solution; mineral–water interaction during the chemical weathering of silicates; biological studies of manganese solution from its dioxide; cationic concentration by freezing, new automated microanalyses for total inorganic fixed nitrogen and for sulfate ion in water; extraction techniques for the determination of cobalt, nickel, and lead in fresh water by atomic absorption; water analysis by atomic absorption and flame emission spectroscopy; analysis of industrial waters by atomic absorption; evaluation of laboratory methods for the analysis of inorganics in water; the differentiation, analysis, and preservation of nitrogen and phosphorus forms in natural waters; atomic fluorescence flame spectrometry; and controls on Mn, Fe, Co, Ni, Cu, and Zn concentrations in soils and water: the significant role of hydrous Mn and Fe oxides. (J.G.B.)

For abstracts of individual papers see: 1772–1775, and 1801.

1772 POLAROGRAPHIC METHODS IN DETERMINATION OF TRACE INORGANICS IN WATER. Maienthal, E. June; Taylor, John K. (National Bureau of Standards, Washington, D. C.). Advan. Chem. Ser.; No. 73, 172-82(1968).

From Symposium on trace inorganics in water; Miami Beach, Fla. (10 Apr 1967).

Polarographic methodology is reviewed, and a survey of the literature concerned with determination of trace inorganic material in water is given. Procedures used for the determination of such elements as aluminum, arsenic, cadmium, copper, indium, iodine, iron, lead, tellurium, and zinc are discussed. The matrices include laboratory distilled water, river water, and reactor cooling water. In addition, a comparative technique is described whereby precisions of better than 1% can be obtained at the 0.1 ppM level. References are given for polarographic methods for the determination of Er, I, U, and Zr, among other elements. (auth)

1773 PRINCIPLES AND PRACTICE OF ATOMIC ABSORPTION. Kahn, Herbert L. (Perkin-Elmer, Norwalk, Conn.). Advan. Chem. Ser.; No. 73, 183-229(1968).

From Symposium on trace inorganics in water; Miami Beach, Fla. (10 Apr 1967).

The basic principles of atomic absorption are described, and the fundamental design and modern improvements in the major components of instrumentation, hollow-cathode lamps, burners, photometers, and monochromators, are discussed. Atomic absorption is compared with some of its rival techniques, principally flame emission and atomic fluorescence. New methods of sampling and the distinction between sensitivity and detection limit are discussed briefly. Detection limits for 65 elements are tabulated. Among them are Cs, Dy, Er, Eu, Gd, Ho, La, Lu, Mo, Nb, Nd, Pr, Sc, Sm, Sr, Tb, Te, Tm, U, Y, Yb, and Zr. (auth)

1774 THIOACETAMIDE-PRECIPITATION PROCEDURE FOR DETERMINING TRACE ELEMENTS IN WATER. Mallory, Edward C. Jr. (Geological Survey, Denver). Advan. Chem. Ser.; No. 73, 281-95(1968).

From Symposium on trace inorganics in water; Miami Beach, Fla. (10 Apr 1967).

When minor elements in water residues are determined spectrographically, major constituents sometimes interfere by producing unpredictable matrix effects, and by diluting the minor elements below limits of detection. Precipitation of minor elements in waters can be used to remove major elements and to concentrate minor ones before spectrographic analysis. In the procedure described here, thioacetamide is used as the precipitant for both the acid and the ammoniacal sulfide groups. Palladium is added to the samples as an internal standard. Tin is added to the acid sulfide group as a spectrographic buffer and coprecipitant; indium is used for the same purposes with the ammoniacal sulfide group. Quantitative precipitations were obtained for aluminum, antimony, arsenic, beryllium, bismuth, cadmium, chromium, copper, iron, lead, lanthanum, titanium, zinc, and zirconium. (auth)

1775 STRONTIUM AND BARIUM CONTENT OF SEA WATER. Andersen, Neil R. (Naval Oceanographic Office, Washington, D. C.). Advan. Chem. Ser.; No. 73, 296-307(1968).

From Symposium on trace inorganics in water; Miami Beach, Fla. (10 Apr 1967).

Concentrations of strontium and barium in seawater were determined simultaneously by a combination of ion exchange concentration and flame photometry to ascertain more precisely strontium/chlorine and barium/chlorine ratios and to investigate the magnitude and nature of the strontium/chlorine ratio variation if it were found. The results of the analyses of several ocean stations presented indicate that there is a small (ca. 3%) but statistically significant variation in the strontium/chlorine ratio with respect to depth in seawater. An indication of a possible variation in the absolute amounts of strontium in seawater with

the geographical location was also observed. The barium/chlorine ratio variation with respect to depth was found to be much larger (ca. 90%) than that of strontium. (auth)

1776 FLAME SPECTROMETRIC AND SOLVENT EXTRACTION STUDIES. Eskew, John Bernard. Knoxville, Tenn.; Univ. of Tennessee (1970). 159p. University Microfilms Order No. 71-17,729.

Thesis.

A rapid and fairly sensitive method for the determination of niobium in steels by flame emission spectrometry was developed. Niobium was separated from iron and other spectral interferences by extraction with methyl isobutyl ketone (MIBK) from an acid solution 6 M in hydrofluoric and hydrochloric acids. Optical conditions for the observation of the 4059 Å niobium line from an oxygen–acetylene flame were investigated. The best detection limit was 9.3 μg/ml when λ = 0.35. The secondary extractions of thallium(III) halides from MIBK to formamide were observed as a function of hydrohalic acid concentration. Thallium was extracted quantitatively into the MIBK layer at acid concentrations of 0.45 M in HBr and 0.02 M in HI for their respective acid–formamide systems, but only 85% of the thallium species was in the MIBK layer for the hydrochloric acid system. For all systems studied greater than 95% of the thallium extracted into the formamide phase at very low acid concentrations in the formamide phase. Extraction characteristics of these halides were examined: Ga(III), In(III), Fe(III), Sn(II), and Sn(IV). All transferred quantitatively to formamide regardless of the acid concentration in the formamide layer. (TSS)

1777 INDIRECT COMPLEXOMETRIC METHOD FOR THE DETERMINATION OF ZIRCONIUM. Sinha, B. C. (Central Glass and Ceramic Research Inst., Calcutta). Indian J. Chem.; 9: No. 2, 178-9(Feb 1971).

A simple and selective method for indirect titration of zirconium, based on an easy process of depolymerization followed by addition of excess EDTA and back titration of the excess EDTA in 0.20 to 0.25 N nitric acid with bismuth nitrate using Xylenol Orange as indicator, is described. The method, unlike many other reported procedures, is not affected by cations such as arsenic(III), nickel(II), or large amounts of titanium, aluminum, and thorium(IV). The interference of mercury(I) and iron(III) is eliminated by hydrochloric acid and ascorbic acid respectively. Fluoride, above 6 mg per 150 ml solution, interferes by bleaching the end point. Most of the other anions do not interfere. (auth)

1778 COULOMETRIC MICRODETERMINATION OF SURFACE WATER ON METALS OR GLASSES AND OF HYDROGEN IN BERYLLIUM. Yoshimori, Takayoshi; Ishiwari, Shuiti; Watanabe, Yoshio; Harada, Takashi; Yamada, Shoji (Science Univ., Tokyo). J. Jap. Inst. Metals; 35: No. 8, 808-12(Aug 1971). (In Japanese).

Water absorbed on the surface of a sample was determined by carrier gas extraction followed by the coulometric titration method. The water was extracted from a heated sample into argon and was transferred to NH_3 with $NaNH_2$. The NH_3 was titrated with the electrolytically generated BrO^- ion. The adsorbed water on the surfaces of steels differed depending on the roughness of the surfaces. The amounts of it on the filed and electropolished samples were 0.5 to 0.7 μg/cm² and 0.2 to 0.3 μg/cm², respectively. These results show that the disturbance of the surface water on the sample is almost negligible in the determination of hydrogen in steel. Fractional determination of the surface water and hydrogen in a stainless steel was also possible. The water was first determined by heating the sample at 100 to 120°C; hydrogen in the sample was extracted at 1100°C and then determined after oxidation to water. Hydrogen in beryllium was extracted into argon by heating the sample at 1100°C and determined by the same method. A sample contained 4.8 ppM of hydrogen. The water evolved from the same metal was also determined, and a considerable amount of water (21 to 23 ppM) was observed by heating the sample at 400 or 800°C. The water evolved from glasses by heating the sample at 300°C was determined by this method. A soft glass evolved 4 to 7 μg/cm² of water, and many hard glasses (Pyrex or others) evolved 0.2 to 0.3 μg/cm² of it. The water on the surface of quartz was only 0.05 to 0.07 μg/cm². (auth)

1779 MICROANALYSIS OF $(U,Pu)O_{2+x}$ SIMULATING DIFFERENT BURNUPS. de Keroulas, Francois; Schmitz, Franz (CEN, Fontenay Aux Roses, France). Trans. Amer. Nucl. Soc.; 14: No. 2, 583-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1780 HYDROGEN MONITORING IN SODIUM SYSTEMS. Rodgers, Douglas N. (General Electric Co., San Jose, Calif.); Collins, Gordon D.; Roy, Prodyot. Trans. Amer. Nucl. Soc.; 14: No. 2, 613-14(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1781 BEHAVIOR AND CALIBRATION OF DEVICES FOR MONITORING IMPURITIES IN SODIUM. Humphreys, J. Ross Jr. (Atomic Energy Commission, Washington, D. C.); Filewicz, E. C.; Greenberg, S.; Skladzien, S. B.; Vilinskas, P. Trans. Amer. Nucl. Soc.; 14: No. 2, 614-15(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1782 ANALYTICAL STANDARDS PROGRAM FOR SODIUM TECHNOLOGY. Cafasso, Fred A.; Meyer, Robert J.; Burris, Leslie (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 616(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1783 ON-LINE SODIUM ANALYSES BY SPARK SOURCE MASS SPECTROSCOPY. Berkey, E.; Sweeney, G. G.; Hickam, W. M. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc.; 14: No. 2, 616-17(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1784 OXYGEN IN LIQUID SODIUM: THERMODYNAMICS AND ELECTROCHEMICAL DETERMINATION. Stavropoulos, G. P.; Cafasso, F. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 621(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1785 EFFECT OF SURFACE/LIQUID PARTITION ON THE ANALYSIS OF IMPURITIES IN A SODIUM SYSTEM. Guon, J. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 625-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1786 FISSION GAS ANALYSIS AT THE HOT CELL. Womack, R. E. (Babcock and Wilcox, Lynchburg, Va.). Trans. Amer. Nucl. Soc.; 14: No. 2, 878(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1787 DETERMINATION OF TETRAVALENT PLUTONIUM WITH CERTAIN 2,7-BIS-AZO DERIVATIVES OF CHROMOTROPIC ACID CONTAINING AN o,o'-DIHYDROXYAZO GROUP. Milyukova, M. S.; Savvin, S. B.; Okhanova, L. A.; Ryzhova, L. V. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 817-21(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 847-51(Nov-Dec 1970).

The interaction of tetravalent plutonium with 2, 7-bisazo derivatives of chromotropic acid containing the o,o'-dihydroxyazo group was studied. It was established that reagents of nonsymmetrical structure, containing o-aminophenols with SO_3H and NO_2 groups in the ortho- and para-positions to the OH group of the benzene ring, and methanilic, anthranilic, or amino-C acids as the second substituent, are the most promising in the analytical respect. It was found that Pu forms complexes with all the reagents, in which the mole ratio Pu : R = 1 : 1. A photometric method of determining Pu(IV) in the presence of uranium and iron without their preliminary separation was developed with one of the reagents of this series, sulfonitrophenol M. (auth)

1788 DETERMINATION OF ZIRCONIUM IN BIOLOGICAL MATERIALS BY ATOMIC ABSORPTION SPECTROMETRY. Grossman, V. B.; Inglis, A. S. (CSIRO, Melbourne). Anal. Chem.; 43: No. 13, 1903-5(Nov 1971).

A simple and precise method for the atomic absorption spectrometric determination of Zr in biological materials is presented. Enhancement of the absorbance of Zr in HF solutions by copper or ferric ions is noted. The effects of chromium ions on the determination were also studied. (J.G.B.)

1789 X-RAY FLUORESCENCE ION EXCHANGE METHOD FOR DETERMINATION OF LANTHANUM, CERIUM, AND PRASEODYMIUM IN CARBON STEELS. Kashuba, A. T.; Hines, C. R. (Jones and Laughlin Steel Corp., Pittsburgh). Anal. Chem.; 43: No. 13, 1758-61(Nov 1971).

A method was devised for simultaneously determining the concentrations of La, Ce, and Pr in carbon steels. The samples are dissolved and their solutions sent through small amounts of ion exchange resin. The dried resin is pelletized and the L_α x-ray fluorescence intensities of the rare earths are obtained. The intensities are compared to a curve obtained from previously prepared elemental standards. Precision of the standard curves is 8 to 14 μg, and detection limits are 0.002 to 0.004%, based on a 2 g steel sample. (auth)

1790 THEORETICAL ANALYSIS OF QUANTITATIVE X-RAY EMISSION DATA: GLASSES, ROCKS, AND METALS. Stephenson, Donald A. (Corning Glass Works, N. Y.). Anal. Chem.; 43: No. 13, 1761-4(Nov 1971).

A new approach to the theoretical treatment of quantitative x ray emission (fluorescence) data gives results for test cases involving glasses, rocks, and metal alloys whose accuracy is comparable with that of good wet-chemical analysis. The method is independent of the spectral distribution of the x ray source and requires only one standard per element analyzed (one standard containing all the elements is also sufficient). The standards can be either pure elements, simple oxides, or up to 20 component mixtures. A computer program, CORSET, applies the necessary corrections for absorption and secondary fluorescence and should permit complete analysis of any homogeneous sample provided the measured x ray intensities of the analyzed elements are obtained with sufficient accuracy. Five glasses were analyzed for 13 components, among which are SrO and ZrO_2. (auth)

1791 X-RAY PHOTOELECTRON SPECTROSCOPY OF MOLYBDENUM COMPOUNDS. USE OF ESCA IN QUANTITATIVE ANALYSIS. Swartz, William E. Jr.; Hercules, David M. (Univ. of Georgia, Athens). Anal. Chem.; 43: No. 13, 1774-9 (Nov 1971).

The Mo ($3d_{\frac{3}{2}}$ to $3d_{\frac{5}{2}}$) electron binding energies were measured as a function of oxidation state for a series of molybdenum compounds. A linear relationship was found to exist between the binding energies and oxidation state. The binding energy shift between the Mo(3d) electrons in MoO_2 and MoO_3 was large enough (1.7 eV) to allow measurement of one oxide in the presence of the other. This permitted development of a quantitative analytical procedure for bulk analysis of MoO_2–MoO_3 mixtures. The resulting analysis shows a relative standard deviation of 2%. (auth)

Radiometric and Radiochemical Procedures

Refer also to abstracts 2198, 2200, 2242, 2252, 2265, and 2276.

1792 (BARC/I–103) DETERMINATION OF ^{235}U CONTENT IN URANIUM OXIDE SAMPLES USING FISSION PRODUCT GAMMA RAYS. Rengan, K.; Ramaniah, M. V. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 9p. INIS.

A method was standardized for determining the ^{235}U content in uranium oxide samples by comparison with a standard using relatively long-lived fission product gamma activities. The ^{235}U ratio can be determined accurately with a standard deviation of about 2% at 95% confidence level in samples having composition close to that of natural uranium. The method is simple as it requires only a single or multichannel analyzer with NaI(Tl) detector after neutron irradiation. However, the most severe limitation is the requirement that the sample and standard be prepared in identical shape and size and should be suitable for irradiation and gamma counting directly. Also, the time required for counting the gamma rays from relatively long-lived fission products obtaining good statistics is rather long running into several hours for each sample. (auth) (INIS)

1793 (IEA–204) RADIOCHEMICAL CONTROL OF RADIOPHARMACEUTICALS: THIN-LAYER CHROMATOGRAPHY. Melo, S. C.; Podlech, P. S.; Barberio, J. C. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Dec 1969. 15p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

A technique of radiochemical quality control by means of thin-layer chromatography on microscopic slides was established for radiopharmaceutical products prepared routinely in the Radiopharmaceutical Division of the Atomic Energy Institute, São Paulo. Hippuran, hipaque, iodophthalamic acid, telepaque, biligrafin, Rose Bengal, and lipiodol labeled with ^{131}I were analyzed for their principal radiochemical impurity, i.e., inorganic iodine. The technique is rapid and sensitive. The autoradiographic analysis detects radioactive substances that could not be identified by chemical means. (auth)

1794 (UCRL–51061) COMPUTERIZED QUANTITATIVE ANALYSIS BY GAMMA-RAY SPECTROMETRY. VOL. III. A USER'S GUIDE TO GAMANAL. Niday, J. B.; Gunnink, R. (California Univ., Livermore. Lawrence Radiation Lab.). 8 Jul 1971. Contract W-7405-eng-48. 18p. Dep. NTIS.

A user's manual for the GAMANAL program is presented that includes input requirements, input card descriptions, and magnetic tape usage. GAMANAL provides a complete qualitative and quantitative analysis of mixtures of radioactive species by computer interpretation of their gamma-ray spectra. (auth)

1795 DETERMINATION OF THE ^{235}U CONTENT OF LOW-ENRICHMENT POWER REACTOR FUEL ASSEMBLIES. Weisbin, C. R. (Los Alamos Scientific Lab., N. Mex.); Augustson, R. H.; Evans, A. E.; Turner, G. D.; Boehnel. K. D. Trans. Amer. Nucl. Soc.; 14: No. 2, 484-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1796 SODIUM IODIDE MEASUREMENTS OF ^{239}Pu, ^{241}Pu, ^{241}Am, AND ^{238}U IN MIXED-OXIDE FUEL RODS. Martin, G. C.; Bishop, D. M. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 486(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1797 DETERMINATION OF ^{226}Ra IN SOILS BY AN α-SCINTILLATION METHOD. Vilenskii, V. D.; Eremenko, Z. V. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 834-9(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 864-70(Nov-Dec 1970).

A method was developed for the determination of ^{226}Ra in soils and other natural objects from a small sample (~2 g). The method is based on the isolation and radiochemical purification of radium isotopes using a barium carrier and α-scintillation determination of ^{226}Ra. The optimum conditions of recording of the α-radiation of ^{226}Ra and its short-lived decay products in mixture of a luminophore and barium sulfate were found. The sensitivity of the method is $\sim 1 \times 10^{-13}$ g/g, with a standard deviation of an individual determination of 10 to 20%. (D.H.M.)

1798 RADIOCHEMICAL DETERMINATION OF PLUTONIUM IN ENVIRONMENTAL AND BIOLOGICAL SAMPLES BY ION EXCHANGE. Talvitie, N. A. (Environmental Protection Agency, Las Vegas, Nev.). Anal. Chem.; 43: No. 13, 1827-30(Nov 1971).

An anion exchange method applicable to the routine determination of plutonium in environmental and biological samples is presented. Samples are initially prepared as azeotropic 6M hydrochloric acid soultions. Pu(IV), stabilized with hydrogen peroxide, is adsorbed on anionic resin from 9M hydrochloric acid solution. Coadsorbed iron is removed from the resin with 7.2M nitric acid. Plutonium is reductively eluted with 1.2M hydrochloric acid–0.6% hydrogen peroxide and electrodeposited from 1M ammonium sulfate at pH 2 for alpha spectrometric determination. Sample preparation procedures are given for urine, animal tissue, bone, saline and nonsaline water, siliceous and limestone soil, and glass fiber air filters. Mean recoveries of ^{236}Pu internal tracer standard from the various types of samples were 83 to 102% with an overall mean of 94%. Minimum detectable activity for 1000-minute counts is 0.02 pCi of ^{239}Pu. (auth)

Activation Procedures

1799 (FRNC-CONF–11) RADIOACTIVATION ANALYSIS OF IRON IN YOUNG DEVELOPING CHICK BLASTODERMS USING $^{56}Fe(p,2n)^{55}Co$ AND A Ge(Li) DETECTOR FOR GAMMA RAY SPECTROMETRY. Bonnet-Masimbert, O.; Prenat, M. F. (Grenoble Univ. (France). Institut des Sciences Nucleaires). 1971. 8p. (CONF-710925–2). Dep. NTIS (U. S. Sales Only).

From International meeting on chemical analysis by charged particle bombardment; Namur, Belgium (5 Sep 1971).

An activation analysis method for determining Fe using a 26-MeV proton beam was developed. This method allowed 20 to 100 ppM of iron diluted in large quantities of proteins and mineral elements to be determined. The incorporation of iron in one blastoderm, from the stage of 1 somite to that of 16 somites, follows an exponential rate and varies with the weight of the ashes. (France)

1800 (FRNC-TH-36) CHANGES IN THE IRON CONTENT IN THE BLASTODERM OF THE CHICKEN EMBRYO IN THE EARLY DEVELOPMENT STAGES: ANALYSIS BY RADIOACTIVATION AND γ SPECTROMETRY. Bonnet-Masimbert, Odile; Prenat, Marie-Francoise (Grenoble Univ. (France)). 1971. 124p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

In order to discover at which stage the blastoderm cells begin to assimilate iron in view of synthesizing hemoglobin, an activation analysis method using a proton beam was developed. The method is rapid, specific, and reproducible. It was possible to demonstrate the existence of large quantities of iron in the blastoderm, and to show that during the blastoderm development the iron content increases without there being a preferential take-up of iron in relation to other elements. (auth)

1801 NEUTRON ACTIVATION ANALYSIS OF LANTHANIDE ELEMENTS IN SEA WATER. Hoegdahl, Ove T. (Central Inst. for Industrial Research, Oslo); Melsom, Sigurd; Bowen, Vaughan T. Advan. Chem. Ser.; No. 73, 308–25(1968).

From Symposium on trace inorganics in water; Miami Beach, Fla. (10 Apr 1967).

Neutron activation analyses of sixteen samples of seawater (eight in duplicate) taken at six widely spaced stations in the Central Atlantic Ocean between 16°N and Equator (depths below 1000 m) showed that the lanthanide patterns are relatively conservative characteristics of water masses. The differences in lanthanide distribution and total abundance between different water masses are small but significant. The absolute mass abundances of the lanthanides can be illustrated by the following values for North Atlantic Deep Water: La — 0.0034 μg/l, Ce — 0.0012 μg/l, Pr — 0.00064 μg/l, Nd — 0.0028 μg/l, Sm — 0.00045 μg/l, Eu — 0.00013 μg/l, Gd — 0.00070 μg/l, Tb — 0.00014 μg/l, Dy — 0.00091 μg/l, Ho — 0.00022 μg/l, Er — 0.00087 μg/l, Tm — 0.00017 μg/l, Yb — 0.00082 μg/l, Lu — 0.00015 μg/l, and Y — 0.0133 μg/l. (auth)

1802 USE OF POST-SAMPLING ACTIVATION ANALYSIS IN SEWAGE TREATMENT PLANTS. Craft, T. F.; Eichholz, G. G. (Georgia Inst. of Tech., Atlanta). Trans. Amer. Nucl. Soc.; 14: No. 2, 469(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1803 CYCLIC NEUTRON ACTIVATION ANALYSIS WITH A ^{252}Cf NEUTRON SOURCE. Gage, S. J.; Atkinson, G. D. Jr.; Bouchey, G. D. (Univ. of Texas, Austin). Trans. Amer. Nucl. Soc.; 14: No. 2, 513-15(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1804 NEUTRON CAPTURE GAMMA-RAY STUDIES OF METALLURGICAL AND MINERAL SAMPLES USING ^{252}Cf. Wiggins, P. F. (Naval Academy, Annapolis, Md.); Duffey, Dick; Senftle, F. E. Trans. Amer. Nucl. Soc.; 14: No. 2, 518-20 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1805 DETERMINATION OF OXYGEN IN LIQUID SODIUM BY PROTON ACTIVATION ANALYSIS. Roche, M. F.; Ross, L. E.; Meyer, R. J. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 617(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1806 ANALYSIS OF COAL USING A ^{252}Cf SOURCE. Rasmussen, Norman C. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc.; 14: No. 2, 931(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1807 ELEMENT SENSITIVITIES FOR ANALYSIS BY THERMAL-NEUTRON CAPTURE GAMMA RAYS. Duffey, Dick (Univ. of Maryland, College Park). Trans. Amer. Nucl. Soc.; 14: No. 2, 931-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1808 PROMPT-NEUTRON ACTIVATION ANALYSIS WITH A ^{252}Cf SOURCE. Greenwood, R. C. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc.; 14: No. 2, 932(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1809 NEUTRON RADIOACTIVE CAPTURE METHODS FOR ELEMENTAL ANALYSIS ON EXTENDED MEDIA. Trombka, J. I. (Goddard Space Flight Center, Greenbelt, Md.); Eller, E. L.; Gerard, J. T.; Senftle, F.; Philbin. P. Trans. Amer. Nucl. Soc.; 14: No. 2, 932-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1810 ANALYTICAL POSSIBILITIES OF A BETATRON WITH INTRACHAMBER IRRADIATION. I. THE ELEMENTS H TO Br. Kuznetsov, R. A. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 885-7(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 908-10(Nov-Dec 1970).

An investigation of the analytical possibilities of the betatron is reported that includes the specific activities and sensitivity of the determination of the elements between H and Br. The inert gases were not included. (D.H.M.)

1811 ISOTOPIC ANALYSIS OF LITHIUM AND BORON ACCORDING TO γ-QUANTA ACCOMPANYING THE NUCLEAR REACTIONS ^{7}Li(α,α′)^{7*}Li, ^{10}B(α,p)^{13*}C. Dzhenard'yan, Yu. A.; Mikhailov, G. I.; Starchik, L. P. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 757-9(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 787-8(Sep-Oct 1970).

A method is proposed for determining the isotopic composition of lithium and boron, based on a measurement of the intensity of the instantaneous γ-radiation accompanying nuclear reactions under the action of the α-particles of isotopic sources. (D.H.M.)

1812 DETERMINATION OF ^{12}C, ^{13}C ISOTOPIC ABUNDANCES AND NITROGEN/CARBON RATIOS IN BIOLOGICAL SUBSTANCES BY PROTON-REACTION ANALYSIS. Ricci, Enzo (Oak Ridge National Lab., Tenn.). Anal. Chem.; 43: No. 13, 1866-71(Nov 1971).

Counting of prompt gamma rays from the reactions ^{12}C(p,γ)^{13}N and ^{13}C(p,γ)^{14}N, induced with 0.7-MeV protons was successfully applied to the determination of the isotopic abundances of ^{12}C and ^{13}C in biological materials. The method allows rapid determinations in biomedical and environmental ^{13}C tracer studies; this stable isotope provides an interesting alternative to ^{14}C, whose use is limited by its radioactivity. Nitrogen-15 could be simultaneously determined by the reaction ^{15}N(p,αγ)^{12}C; thus the elemental ratio N/C, proportional to the isotopic ratio ^{15}N/^{12}C in natural biological samples, was also studied. Samples of human lung, brain, and Escherichia coli were analyzed against urea, benzamide, and graphite standards. Relative standard deviations were 4.8 to 8.6% and 4.8 to 9.0% for the determinations of ^{13}C isotopic abundances and of ratios N/C, respectively. Therefore, a 20% variation is observable and the method can, for example, determine an increase in the ^{13}C abundance from the natural 1.11% (average) to only 1.33%. An accuracy check of the ^{13}C determination, with reference to mass spectrometric results, gave a relative error of only −1.8% for proton reaction analysis. Ease and speed are important advantages of this technique over mass spectrometry and nuclear magnetic resonance, and its error is compatible with the natural variation of biological results. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstract 2239.

Chemical Properties

Refer also to abstract 3592.

1813 (SRARI-P-95) INVESTIGATION OF THE INTERACTION OF NEPTUNIUM(V) WITH IONS OF URANIUM(VI), IRON(III), AND THORIUM(IV). Frolov, A. A.; Rykov, A. G. (Scientific Research Atomic Reactor Inst., Melekess (USSR)) 1970. 38p. (In Russian). Dep. NTIS (U. S. Sales Only).

Under spectrophotometric investigations of the interaction of neptunium(V) with uranium(VI), iron(III), and thorium(IV) in perchlorate, nitrate, and chloride solutions it was found that neptunium(V) existed only in two spectral forms the connection between which was expressed by simple ratios: $C_I = C_{Np(V)}\, e^{-\alpha C_x + m}$ and $C_{II} = C_{Np(V)}\,(1 - e^{-\alpha C_x + m})$, where $C_x + m$ is the total concentration of the "active" cation. The effective α constant depends on both the nature and the concentration of anions being present in the solution, but does not depend on total ionic strength of the solution. The supposition about the possible mechanism of cation-cation interactions was made. (auth)

1814 STUDY OF THE COLOR REACTION BETWEEN Th(IV) AND A PYRAZOLONIC DERIVATE. Patroescu, C.; Cruceru, D.; Lupu, F. (Univ., Bucharest). Chim. Anal. 1: No. 2, 111-13(Apr-Jun 1971). (In Rumanian).

The results are given of a spectrophotometric study concerning the reaction between Th(IV) and the potassium salt of 4-hydroxy-3-[(3-methyl-5-oxo-1-phenyl-2-pyrazolin-4-yl)azo] benzenesulfonic acid. The optimum conditions in which the reaction develops are: pH = 5.6; 1.75×10^{-4}M dye; λ = 480 nm. The combination ratio is 1 : 2 and the molar extinction coefficient expressed in $cm^2\ mol^{-1}$ is 1.3×10^4. In the reaction, the ions Zr(IV), U(VI), Pd(II), and Mo(VI) interfere. (auth)

1815 REACTION OF OXYGEN WITH RARE EARTH ELEMENTS AND THORIUM IN ALKALI CHLORIDE MELTS. Fam Ngok T'en; Morozov, I. C. Zh. Neorg. Khim.; 16: No. 6, 1683-8(Jun 1971). (In Russian).

The oxychlorides of rare earth elements and thorium were synthesized by a reaction of the corresponding anhydrous chlorides with Sb_2O_3 at temperatures below 450°C. The interaction of rare earth oxychlorides with $TbCl_4$, $TbCl_4 + ROCl \rightarrow RCl_3 + ThOCl_2$ where R = a rare earth was studied. At 700°C the equilibrium was shifted to the right owing to the decomposition of $ThOCl_2$ to ThO_2. In another set of experiments the oxidation of a 1 : 1 mixture of $TbCl_4$: RCl_3 was studied by blowing air through the mixture dissolved in NaCl−KCl melts at 500 to 800°C. (K.S.W.)

1816 DISPROPORTIONATION RATE OF URANIUM(V) IN SULFURIC ACID SOLUTION. Stabrovskii, A. I. Zh. Neorg. Khim.; 16: No. 6, 1667-71(Jun 1971). (In Russian).

The disproportionation of the uranium (V) ion in H_2SO_4 solution was studied as a function of temperature and acidity. The U(V) ion was generated by electrochemical reduction at a plantinum cathode. The disproportionation reaction proceeded at a velocity that was a function of the acidity of the solution, the temperature, and the concentration of U(V). The velocity constant was measured at 10, 25, and 40°C at constant U concentration, and over the H_2SO_4 concentration range 0.0025, 0.05, and 0.25 mole/liter at constant temperature (25°C). The energy of activation was calculated from the above data to be 7,650 cal/mole. (K.S.W.)

1817 HYDRIDING REACTION BETWEEN PLUTONIUM AND DEUTERIUM. Bowersox, David F. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 578-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1818 ELECTROCHEMICAL MEASUREMENT OF THE SOLUBILITY OF CARBON IN SODIUM. Salzano, F. J.; Newman, L. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 623(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1819 OXYGEN REACTIONS WITH IMPURITIES IN SODIUM. Isaacs, H. S. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 623-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1820 OXIDATION OF NEPTUNIUM(VI) BY HYPOBROMITE IONS. Shilov, V. P.; Krot, N. N.; Gel'man, A. D. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 870-2(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 896-8(Nov-Dec 1970).

Hypobromite ions oxidize neptunium(VI) rather rapidly in 4 to 6 M alkali at 70 to 80°C and a concentration of the oxidizing agent of 0.05 to 0.1 M. The reaction rate is first order with respect to neptunium(VI) fractional with respect to hypobromite, and depends sharply on the alkali concentration. The activation energy in the interval 50 to 80° is 21 ± 1 kcal/mole ($[OH^-]$ = 6.5 g-ion/liter). The addition of copper, nickel, or cobalt substantially accelerates the oxidation of neptunium(VI) by hypobromite ions. (auth)

1821 OXIDATION OF NEPTUNIUM(VI) BY PLUTONIUM(VII) AND MANGANESE(VII). Shilov, V. P.; Krot, N. N.; Gel'man, A. D. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 888(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 911(Nov-Dec 1970).

When 1 ml of 5×10^{-3} M Pu(VII) is added to 20 ml of 2.6×10^{-4} M Np(VI) in 1 M NaOH, the blue color characteristic of Pu(VII) disappears several seconds after the solutions are mixed and the green color of Np(VII) appears. Spectrophotometric measurement confirmed the fact that Pu(VII) oxidizes an equivalent amount of Np(VI). When a 1×10^{-2} M solution of $KMnO_4$ is added dropwise to a 5×10^{-4}M solution of Np(VI) in 4 M NaOH, Np(VII) and MnO_4^{2-} ions rapidly arise. (D.H.M.)

1822 COPRECIPITATION OF BARIUM WITH A PROTOTYPE OF BONE MINERAL, CALCIUM HYDROXYLAPATITE. Mikhailova, A. I. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 859-61(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 887-9(Nov-Dec 1970).

The distribution of microquantities of barium between phases in coprecipitation with calcium hydroxylapatite (a prototype of bone mineral) varies with the age of the precipitate. Barium is transferred to freshly formed precipitates somewhat more completely than calcium; the recrystallized precipitates have a low barium content. The initial and equilibrium distribution of barium between phases does not depend on its concentration. It is concluded that the equilibrium distribution of barium is determined entirely by its isomorphous cocrystallization with calcium hydroxylapatite. The coefficients of crystallization D and λ characterizing the distribution of the microcomponent between the phases in the case of isomorphous cocrystallization were calculated. The value of the coefficient λ remains constant as calcium precipitates and close to the corresponding value determined earlier in experiments with strontium ($\lambda_{Sr} = 0.53 \pm 0.08$; $\lambda_{Ba} = 0.60 \pm 0.11$). It was hypothesized that the increased capture of barium by freshly formed precipitates of calcium hydroxylapatite is explained by volume coprecipitation of barium with amorphous calcium phosphate, present in these precipitates, into which barium is transferred more completely than into crystalline apatite. In such a case the cause of the increased sorption of barium by preparations of bone tissue in experiments in vitro is its transfer to the amorphous phosphate present in the bone mineral. (auth)

1823 COPRECIPITATION OF STRONTIUM WITH A PROTOTYPE OF BONE MINERAL, CALCIUM HYDROXYLAPATITE. Popov, D. K.; Mikhailova, A. I.; Basalaeva, L. N. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 856-8(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 885-6(Nov-Dec 1970).

The distribution of microquantities of strontium between phases in the case of coprecipitation with calcium hydroxylapatite (a prototype of bone mineral) does not depend on the recrystallization of the precipitate and on the concentration of strontium, i.e., is entirely determined by isomorphous cocrystallization. The coefficients of crystallization D and λ, characterizing the distribution of the microcomponent between phases during isomorphous cocrystallization, were calculated. The value of the coefficient λ remains constant as calcium precipitates and is equal to 0.53 ± 0.08, i.e., the true mixed crystals formed are poor in strontium. (auth)

1824 SOME PRINCIPLES OF D. I. MENDELEEV'S PERIODIC SYSTEM AND THE PREDICTION OF THE CHEMICAL PROPERTIES OF ULTRAHEAVY ELEMENTS. Chaikhorskii, A. A. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 771-7(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 801-8(Nov-Dec 1970).

A new variation of D. I. Mendeleev's periodic system of the elements is presented that was constructed on the basis of the principle of symmetry and extrapolation of the available data on the chemical properties and electronic configurations of the elements. The table is presented in the form of a long period system consisting of 10 periods or five diads. In all the periods, the elements possessing the same electron shells are arranged one after the other, with the exception of the elements with s-shells, which are placed at the beginning of the period. In the ninth and tenth periods after filling of the $8s^2$-sublevel, the 5g-shells appear containing 18 electrons. Electronic configurations were proposed for ultraheavy elements, permitting a prediction of their basic chemical properties. (D.H.M.)

1825 INFLUENCE OF THE NATURE OF THE SOLVENT ON THE FORMATION OF MIXED CRYSTALS OF PROMETHIUM WITH MOLYBDATES OF THE ALKALINE EARTH METALS FROM A MELT. I. COCRYSTALLIZATION OF PROMETHIUM WITH STRONTIUM MOLYBDATE. Kolysh, A. V.; Kryukova, A. I.; Korshunov, I. A. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 778-82(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 808-14(Nov-Dec 1970).

It was shown that the coefficient of crystallization of Pm when it is distributed between a melt and crystals of $SrMoO_4$ in chloride systems decreases from the system with LiCl to the systems with NaCl, KCl, RbCl, and CsCl. The decrease in the coefficient of crystallization, D, is explained by the formation of complex compounds of the microcomponent with the solvent, on the one hand, and the change in the solubility of the macrocomponent, on the other. It was noted that the coefficient D does not depend on the temperature in the temperature interval 750 to 850°C. (auth)

1826 INFLUENCE OF THE NATURE OF THE SOLVENT ON THE FORMATION OF MIXED CRYSTALS OF PROMETHIUM WITH MOLYBDATES OF THE ALKALINE EARTH METALS FROM A MELT. II. COCRYSTALLIZATION OF PROMETHIUM WITH CALCIUM MOLYBDATE. Kolysh, A. V.; Kryukova, A. I.; Korshunov, I. A. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 783-7(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 814-18(Nov-Dec 1970).

The coefficients of crystallization of Pm with calcium molybdate in a melt of Li, Na, K, and Cs chlorides were determined. The influence of the nature of the solvent on the distribution of the microcomponent between the solid phase and the melt was studied. It was shown that the coefficient of crystallization of Pm in the case of its distribution between the melt and crystals of $CaMoO_4$ decreases when the solvent LiCl is replaced by NaCl, KCl, and CsCl, which is explained (by analogy with the systems with $SrMoO_4$) by the phenomenon of complex formation between the microcomponent and the solvent. It was noted that the coefficient of crystallization does not depend on the temperature in the temperature interval 750 to 850°C. The data on the coefficients of cocrystallization of microquantities of Pm with $CaMoO_4$ and $SrMoO_4$ in various solvents of the MCl type, where M = Li, Na, K, Rb, and Cs, were compared. (auth)

1827 USE OF THE METHOD OF PARTIAL RECRYSTALLIZATION TO DETERMINE THE COEFFICIENT OF CRYSTALLIZATION λ IN THE CASE OF HETEROGENEOUS DISTRIBU-

TION OF A MICROIMPURITY. II. THE SYSTEM $Th(C_2O_4)_2 \cdot 6H_2O - Eu(III)(Pu(IV)) - (HNO_3 + H_2C_2O_4 + H_2O)$. Grebenshchikova, V. I.; Bryzgalova, R. V.; Rogozin, Yu. M. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 788-92(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 818-24(Nov-Dec 1970).

It was established that in the recrystallization of a thorium oxalate precipitate, the distribution of a microimpurity [plutonium(IV) and europium(III)] in the recrystallized portion of the precipitate is heterogeneous. The possibility of using the method of partial recrystallization to determine the coefficients of crystallization λ' was demonstrated experimentally. It was shown that the capture of an isomorphous impurity (Pu[IV]), an impurity forming anomalously mixed crystals with the macrocomponent [Eu(III)], and the capture of the isotope ^{14}C, which is contained in the anion of the macrocomponent, are determined by the same process of recrystallization of the thorium oxalate precipitate. (auth)

1828 SORPTION OF EUROPIUM BY THE SURFACE OF A THORIUM OXALATE PRECIPITATE. Grebenshchikova, V. I.; Bryzgalova, R. V.; Rogozin, Yu. M.; Chernitskaya, I. V. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 793-7(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 824-9(Nov-Dec 1970).

On the basis of a study of the processes of capture of europium (III) in the recrystallization of a thorium oxalate precipitate, the primary nature of the sorption of europium(III) was confirmed. The influence of the saturation of the surface of the thorium oxalate precipitate on its recrystallization established is a characteristic feature of systems formed by heterovalent isomorphous components. It was shown that the sorption of europium on the surface of a thorium oxalate precipitate does not depend on the thorium concentration in solution. The distribution of europium between the surface of the precipitate and the solution obeys the Nernst law. It was hypothesized that the oxalate ion participates directly in the sorption of europium; moreover, the sorption of europium is accompanied by the formation of point defects of the crystal lattice of thorium oxalate. (auth)

1829 INTERACTION OF URANIUM OCTOXIDE WITH ACIDS. Blinova, N. I.; Rodionova, L. P.; Tolmachev, Yu. M. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 804-7(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 835-8(Nov-Dec 1970).

Some conclusions from a study of the interactions of U_3O_8 with acids are: When U_3O_8 is dissolved in acetic acid in the concentration interval from 0.3 to 17.2 M, the lowest equilibrium oxide is the oxide $UO_{2.57}$, formed in 7.0 M CH_3COOH. When U_3O_8 is dissolved in perchloric acid in the concentration interval from 0.25 to 2.0 N, the lowest equilibrium oxide is uranium pentoxide U_2O_5 ($UO_{2.50}$). When U_2O_5 is dissolved in acetic and perchloric acids, the same equilibrium oxides are obtained as in the dissolution of U_3O_8 in acids with the same concentration. In this case there is a predominant passage of U(IV) into solution. As a result of the interaction of U_3O_8 with 1 N nitric acid in the presence of anthranilic acid, uranium pentoxide U_2O_5 is formed. X-ray diffraction study indicated the presence of a hexagonal phase characteristic of the oxide U_2O_5 in the equilibrium oxides (with composition up to $UO_{2.57}$). (auth)

1830 OXIDATION OF U_2O_5 AT TEMPERATURES BELOW 100°C. Osipova, V. V. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 808-12(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 839-43(Nov-Dec 1970).

A detailed investigation of the products of the oxidation of U_2O_5 at temperatures below 100°C is reported. A large number of experiments indicated that the highest oxidation product of U_2O_5 under the conditions studied should be considered to be the oxide $UO_{2.635}$. (D.H.M.)

1831 POLAROGRAPHIC REDUCTION OF TRIVALENT AMERICIUM IN ACETONITRILE MEDIUM. Myasoedov, B. F.; Myuzikas, K. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 826-9(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 856-9(Nov-Dec 1970).

The polarographic reduction of trivalent americium and plutonium on a dropping mercury electrode was studied in a 0.1 M solution of tetraethylammonium perchlorate in acetonitrile. Two waves are observed in the case of americium; the height of the second wave is twice as great as the height of the first. The half-wave potential with respect to a saturated calomel electrode is equal to –1.65 and –2.0 V. The polarogram of plutonium has only one wave. The two waves on the polarogram of americium are explained by successive electrochemical reactions: $Am^{3+} + e \rightarrow Am^{2+}$, $Am^{2+} + 2e \rightarrow Am(Hg)$. (auth)

1832 HEPTAVALENT STATE OF THE TRANSURANIUM ELEMENTS. XI. THE INTERACTION OF PLUTONIUM(VII) WITH CERTAIN REDUCING AGENTS IN ALKALINE SOLUTIONS. Komkov, Yu. A.; Krot, N. N.; Gel'man, A. D. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 656-60(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 692-6(Sep-Oct 1970).

The kinetics of the reduction of plutonium(VII) in 0.5 to 4 M KOH by iodide and iodate ions was studied by a spectrophotometric method. The influence of various factors on the rate of these reactions was determined, and the possible mechanism of their occurrence was considered. (auth)

1833 DETERMINATION OF THE STABILITY CONSTANTS OF COMPLEX COMPOUNDS OF CALIFORNIUM WITH ETHYLENEDIAMINETETRAACETIC AND 1,2-DIAMINOCYCLOHEXANETETRAACETIC ACIDS BY AN ELECTROMIGRATION METHOD. Stepanov, A. V.; Maksimova, A. M.; Pazukhin, E. M.; Belov, L. M. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 690-2(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 727-30(Sep-Oct 1970).

The stability constants of ethylenediaminetetraacetate and 1,2-diaminocyclohexanetetraacetate complexes of californium were determined by the method of electromigration on a porous filler. (auth)

1834 SPECTROPHOTOMETRIC STUDY OF COMPLEX FORMATION AND SOLVATION OF IONS OF THE ACTINIDE ELEMENTS. II. URANIUM(IV) IN NITRATE SOLUTIONS. Rykov, A. G.; Vasil'ev, V. Ya. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 681-9(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 717-27(Sep-Oct 1970).

It was established by the method of measuring the differential spectra that uranium(IV) exists in nitrate solutions in only three spectrally distinguishable forms. It was shown that the increase in the concentrations of the forms of uranium(IV) to which the second and third (hexanitrate) absorption spectra belong is caused by the action of various factors. It was suggested that this reflects differences in the nature of these forms. An empirical equation was found relating the concentrations of the first two forms of uranium(IV) to the total concentration of nitrate ions. (auth)

1835 SPECTROPHOTOMETRIC STUDY OF COMPLEX FORMATION AND SOLVATION OF IONS OF THE ACTINIDE ELEMENTS. I. THE "DIFFERENTIAL-SPECTRA" METHOD. Rykov, A. G.; Vasil'ev, V. Ya. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 675-80(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 711-17(Sep-Oct 1970).

A critical examination of the widespread spectrophotometric methods of determining the stability constants of complex compounds formed in solution shows that a necessary condition for obtaining reliable results is an independent determination of the number of complex forms produced. Evidence of the existence of various complexes based only on an analysis of the curves of the optical density versus the composition of the solution may be erroneous on account of inconstancy of the activity coefficient in the presence of a substantial change in the composition of the solutions. It was proposed that the constancy of the contours of "differential" absorption spectra be used as an independent criterion of the presence of only two absorbing forms within some range concentrations of the ligand. It was shown that the method of "differential-spectra" is more rigorous and general than the method of isobestic points. (auth)

1836 TRAPPING OF EUROPIUM BY A THORIUM OXALATE PRECIPITATE. Grebenshchikova, V. I.; Bryzgalova, R. V.; Rogozin, Yu. M. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 669-74(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 705-10(Sep-Oct 1970).

In the system $Th(C_2O_4)_2 \cdot 6H_2O - Eu^{3+} - H_2C_2O_4 - HNO_3$ europium is initially sorbed on the prepared surface of the thorium oxalate precipitate with a limit of sorption. The europium initially sorbed on the surface of a thorium oxalate precipitate is capable of equivalent exchange for elements with properties close to it (Y) but does not compete with the macrocomponent for adsorption sites. It was hypothesized that the distribution of europium between the thorium oxalate precipitate and the solution in the case of isothermal removal or supersaturation is not determined by processes analogous to the processes of sorption on the proposed surface of a thorium oxalate hexahydrate precipitate. (auth)

1837 SUPPLEMENTARY DATA ON THE OXIDATIVE PROPERTIES OF NEPTUNIUM(VII) IN ALKALINE SOLUTIONS. Shilov, V. P.; Krot, N. N.; Gel'man, A. D. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 661-3(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 697-9(Sep-Oct 1970).

The dependence of the potential of the neptunium(VII)/neptu-

nium(VI) couple on the alkali concentration at constant ionic strength was determined. It was established that the transition of neptunium(VI) into the heptavalent state proceeds with the participation of two OH^- ions. In 1 M NaOH at 25°C, the formal potential of the neptunium(VII)/neptunium(VI) couple was found equal to 587.5 ± 1.5 mV. (auth)

1838 REDUCTION OF U_3O_8 TO U_2O_5 BY AN AQUEOUS SOLUTION OF U(IV) SULFATE. Moskal'kova, E. A.; Tolmachev, Yu. M. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 723-6(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 758-62(Sep-Oct 1970).

It was established that U(IV) sulfate, present in aqueous solution, readily reduced uranium octoxide to U_2O_5. It was shown that the interaction proceeds according to the equation: $2U_3O_{8sol} + U^{4+}_{aq} + H_2O = 3U_2O_{5sol} + UO^{2+}_{2aq} + 2H^+$. (auth)

1839 PRODUCTION OF CONCENTRATED SOLUTIONS OF NEPTUNIUM(VII). Blokhin, V. I.; Krot, N. N.; Gel'man, A. D. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 764(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 792(Sep-Oct 1970).

A method is described for preparing solutions with high concentrations of neptunium(VII) by oxidation of a suspension of neptunates in solutions of lithium hydroxide with ozone. (D.H.M.)

1840 STATE OF ^{137}Cs AND ^{90}Sr IN SEWAGE SOLUTIONS IN THE PRESENCE OF SYNTHETIC DETERGENTS AND SOAPS. Shvedov, V. P.; Yakushev, M. F.; Vekhvilyainen, R. M.; Permyakov, A. A. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 754-6 (Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 784-6(Sep-Oct 1970).

^{137}Cs exhibits a complex behavior in sewage solutions in the presence of synthetic detergents and soaps, due to the dependence of its state on the pH and time of exposure of the solution. At pH = 5 and a time of exposure of the solution of ~7 days, about 70% of the ^{137}Cs is in the suspended state in the form of a coarsely dispersed phase. Regardless of the pH, in the case of exposure for more than 25 days, practically all the ^{137}Cs passes into the truly soluble state. In such systems ^{90}Sr (in contrast to ^{137}Cs) is irreversibly transferred to the suspended phase. The rate of transfer to the suspended phase, which depends on the rate of establishment of equilibrium in the system $Ca(OH)_2-CaCO_3$ (in the case of the absorption of CO_2 from air), has a maximum at pH 7. (auth)

1841 VIBRATIONAL ENERGY DISTRIBUTION THROUGH CHEMICAL LASER STUDIES. II. FLUORINE ATOMS PLUS CHLOROFORM. Parker, John H.; Pimentel, George C. (Univ. of California, Berkeley). J. Chem. Phys.; 55: No. 2, 857-61 (15 Jul 1971).

Laser emission by HF from the UF_6-CCl_3H chemical laser system and by DF from the UF_6-CCl_3D system was studied, the latter by the equal-gain temperature technique. For HF, v = 2 → 1 and 3 → 2 transitions were observed, with $P_{2-1}(3)$ reaching threshold first at room temperature. For DF, v = 2 → 1, 3 → 2, and 4 → 3 transitions were observed, with $P_{3-2}(4)$ reaching threshold first at room temperature. The abstraction reaction $F + CCl_3H$ (CCl_3D) is about 8 kcal more exothermic than the corresponding methane reaction, which accounts for the appearance of the higher v transitions. The DF zero-pressure, equal-gain temperature of 386 ± 10°K establishes $k_3/k_2 = 1.54$, the same, within experimental uncertainty, as that observed for the less exothermic $F + CD_4$ reaction. (auth)

Isotope Effects and Exchange

1842 CHEMISTRY OF BIVALENT CARBON INTERMEDIATES. VI. THE PHOTOLYSIS OF 2-n-BUTYLPHENYLDIAZOMETHANE. Baer, Ted A.; Gutsche, C. David (Washington Univ., St. Louis). J. Amer. Chem. Soc.; 93: No. 20, 5180-6(6 Oct 1971).

The photolysis of 2-n-butylphenyldiazomethane (1) in cyclohexane was shown in an earlier investigation to yield 2-ethylindan (3), 2-methyltetralin (4), benzosuberan (5), and trans-1-(o-tolyl)-2-butene (7). A reinvestigation of the product mixture from this reaction has revealed that, in addition to these compounds, 1-n-propylbenzocyclobutene (2), 1-n-butyl-2-cyclohexylmethylbenzene (6), and cis-1-(o-tolyl)-2-butene (8) are also present. The ratio of these products has been carefully measured, and it has been found that it is the same whether the irradiation is effected directly or via photosensitization. This unexpected result is interpreted in terms of an equilibrium between the singlet and triplet species of the arylcarbene, the rate of equilibration being more rapid than the rates of the ensuing processes leading to intramolecular C–H insertion (i.e., to forms 2-5), intermolecular C–H insertion (i.e., to form 6), and hydrogen migration (i.e., to form 7 and 8). In an attempt to gain insight into the mechanism of formation of the olefins 7 and 8, deuterated analogs of 1 were prepared, viz. the β,β-dideuterio compound ($1-\beta_2$), the γ,γ-dideuterio compound ($1-\gamma_2$), and the $\beta,\beta,\gamma,\gamma$-tetradeuterio compound ($1-\beta_2\gamma_2$). Analysis of the product ratios in the mixtures formed by irradiation of these compounds revealed a deuterium isotope value of 3.1 to 3.4 for the C–H insertion to form 2-ethylindan (3), a value of 1.6 to 1.8 for the C–H insertion to form 2-methyltetralin (4), a value of 3.3 for the formation of olefin from $1-\beta_2$, a value of 1.5 for the formation of olefin from $1-\gamma_2$, and a value of 7.2 for the formation of olefin from $1-\beta_2\gamma_2$. The close similarity of deuterium isotope effect between the formation of 3 and olefin from $1-B_2$ and 4 and olefin from $1-\gamma_2$, in conjunction with the fact that the product of the deuterium isotope values for olefin formation from $1-\beta_2$ and $1-\gamma_2$ is approximately equal to that for olefin formation from $1-\beta_2\gamma_2$, suggests an intimate mechanistic relationship between C–H insertion and olefin formation. (auth)

1843 GROUND-STATE SUBSTITUENT EFFECTS. I. DEUTERIUM AND METHYL. Barborak, J. C.; Chari, Sarangan; Schleyer, P. v. R. (Princeton Univ., N. J.). J. Amer. Chem. Soc.; 93: No. 20, 5275-7(6 Oct 1971).

A study was made of substituent effects on cyclopropyl rings using the deuterated and methylated barbaralones. It was determined from the normal and low-temperature PMR spectra that a deuterium isotope effect did exist, favoring attachment of deuterium to the cyclopropanoid positions. (D.H.M.)

1844 ACIDITY OF HYDROCARBONS. XXXVIII. KINETIC ACIDITY AND BROENSTED CORRELATION OF DI- AND TRIARYLMETHANES WITH METHANOLIC SODIUM METHOXIDE. Streitwieser, A. Jr.; Hollyhead, W. B.; Sonnichsen, G.; (and others) (Univ. of California, Berkeley). J. Amer. Chem. Soc.; 93: No. 20, 5096-5102(6 Oct 1971).

Exchange rates and isotope effects are reported for polyarylmethanes in methanolic sodium methoxide. Tritium exchange rates given as 10^7k_2 (M^{-1} sec^{-1} at 100°), ΔH^* (kcal/mol), and ΔS^* (eu) are, respectively, 10-phenyl-9,9-dimethyldihydroanthracene (PDDA), 533, 27.80, −4.05; p-biphenylyldiphenylmethane (BDM), 42.7 28.88, −6.14; p-dibiphenylylmethane (DBM), 30.5, 30.20, −3.33; triphenylmethane (TPM), 13.8, 32.28, 0.70; diphenylmethane (DPM), 1.65, 33.80, 0.56. Kinetic primary isotope effects are relatively small; k_D/k_T at 100° are PDDA, 1.64; TPM, 1.34; DPM, 1.52. These reduced isotope effects are shown to result from internal return by interrelating H, D, and T exchange with TPM. These five hydrocarbons give an excellent Brønsted acidity correlation with a line of $\alpha = 0.46$ (at 100°) that shows no sign of curvature. The correlation is different in slope and displaced from the similar linear Brønsted correlation demonstrated previously for fluorene-type hydrocarbons. The significance of this difference is discussed. (auth)

1845 ELECTROPHILIC SUBSTITUTION AT SATURATED CARBON. XLVIII. HIGH STEREOSPECIFICITY IN A TRANSAMINATION REACTION. Guthrie, Robert D.; Jaeger, David A.; Meister, Willi; Cram, Donald J. (Univ. of California, Los Angeles. Univ. of Kentucky, Lexington). J. Amer. Chem. Soc.; 93: No. 20, 5137-53(6 Oct 1971).

Pivalaldehyde-1-d and optically pure α-phenylethylamine were condensed to their imine derivative, N-(neopentylidene-1-d)-α-phenylethylamine (I-H,D). This material when heated at 75° with potassium tert-butoxide in tert-butyl alcohol, isomerized through an azaallylic anion to give 97% optically pure N-(α-methylbenzylidene)neopentylamine-1-d (II-D), which was hydrolyzed to optically active neopentylamine-1-d and then converted back to II-D. The optical purity of II-D was demonstrated by its reduction with lithium aluminum hydride to N-(neopentyl-1-d)-α-phenylethylamine, which was resolved. The enantiomers were examined for stereochemical purity by NMR measurements. Rates of isomerization at 75°C were examined with all combinations of isotopic labels (deuterium and protium) in the benzyl position of optically pure starting material and in the tert-butyl alcohol. Equilibrium constants between starting and rearranged imine were determined at 75°C in dimethyl sulfoxide–methanol–potassium methoxide and were found to favor product by a factor of 23. Kinetic analysis provided the following facts. Starting imine underwent isotopic exchange 21 to 36 times as fast as it racemized. The intramolecularity for the rearrangement varied from 46% when protium was transferred to 8% when deuterium was transferred. The higher value involved protonated substrate and deuterated medium, and the lower value, deuterated substrate and protonated medium. The ratio of the rate constant for isotopic exchange that gave starting imine to that for isotopic exchange that gave rearranged imine, termed the collapse ratio, was found to be dependent on the original positions of the isotopic labels. The collapse ratio favored starting imine over rearranged imine by factors of 3.0 and 5.7. The lower

value involved deuterated substrate and protonated medium, and the higher value, protonated substrate and deuterated medium. Use of an average collapse ratio of 4.4 ± 1.3 and an isotope effect free model allowed calculation of the rate constants for the invisible reaction of formation of ion pair and return to starting material and the rate constants for total ionization. In all cases, the rate constants for the invisible reaction were lower valued than those for isotopic exchange of starting material. Isotope effects for all processes were calculated. (auth)

1846 ACIDITY OF HYDROCARBONS. XXXVII. THE BROENSTED CORRELATION AND HYDROGEN ISOTOPE EXCHANGE KINETICS OF FLUORENES, BENZFLUORENES, AND INDENE WITH METHANOLIC SODIUM METHOXIDE. Streitwieser, A. Jr.; Hollyhead, W. B.; Pudjaatmaka, A. H.; (and others) (Univ. of California, Berkeley). J. Amer. Chem. Soc.; 93: No. 20, 5088-96(6 Oct 1971).

Kinetic results are reported for tritium exchange of several hydrocarbons related to fluorene with methanolic sodium methoxide. The second-order rate constant for fluorene increases with NaOMe concentration and a comparison with H_- results is presented. Primary isotope effects are high and indicate the absence of significant amounts of internal return. k_H, k_D, and k_T are interrelated for 9-phenylfluorene and 9-methylfluorene. The secondary isotope effect for exchange of fluorene-9,9-d_2 is 15%. Tritium exchange rates given as $10^4 k_2$ (M^{-1} sec^{-1}) at 45°, ΔH^* (kcal/mol), and ΔS^* (eu) are, respectively, 1,12-o-phenylene-7,12-dihydropleiadene, 5630, 17.13, −5.99; 9-phenyl-3,4-benzfluorene, 1030, ..., ...; 9-phenylfluorene, 173, 21.30, 0.20; 3,4-benzfluorene, 90.3, 20.95, −2.20; indene, 50.0, 20.29, −5.43; 1,2-benzfluorene, 31.9, 18.49, −11.98; 4,5-methylenephenanthrene, 6.85, 23.66, 1.21; fluorene, 3.95, 23.26, −1.16; 2,3-benzfluorene, 2.15, ..., ... These rates give a linear Brønsted plot with pK's derived from cesium cyclohexylamide with a slope, α, of 0.37. No curvature is detectable in this correlation. The significance of the value of α is discussed. (auth)

1847 OPPOSED EFFECTS OF THE SUBSTITUTION OF HYDROGEN BY DEUTERIUM ON THE DISSOCIATION ENERGY OF THE HYDROGEN BOND AND THE VAN DER WAALS INTERACTION ENERGY. Rabinovich, I. B.; Tsvetkov, V. G. (Gorky State Univ., USSR). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 4, 458(Apr 1971).

Translated from Zh. Fiz. Khim.; 45: No. 4, 822-3(Apr 1971).

The consolute temperatures (T_c) for mixtures of cyclohexane and deuterocyclohexane (C_6D_{12}) with methanol and deuteromethanol (CH_3OD) and also of cyclohexane and decane with aniline and deuteroaniline ($C_6H_5ND_2$) were determined. The substitution by deuterium of a hydrogen atom involved in hydrogen bonding leads to an increase of T_c and a decrease of the miscibility of the components. The replacement of hydrogen by deuterium in cyclohexane has the opposite effects. (auth)

1848 INFRARED SPECTRUM OF THE $BrHBr^-$ ION ISOLATED IN AN ARGON MATRIX. Milligan, Dolphus E.; Jacox, Marilyn E. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys.; 55: No. 5, 2550-60(1 Sep 1971).

Infrared absorptions assigned to ν_3, $(\nu_3 + \nu_1)$, and $(\nu_3 + 2\nu_1)$ of $BrHBr^-$ were observed in samples of HBr in an argon matrix subjected to 1216-Å photolysis or co-deposited with an alkali metal atomic beam and then subjected to mercury-arc radiation. The corresponding experiments on deuterium-enriched samples support this identification. Mechanisms by which $BrHBr^-$ is produced in these experiments are considered in detail. An atomic mechanism leading to the stabilization of the uncharged species is shown to be inadequate. However, several ionic processes may contribute to the observed production of the anion. As previously postulated, dissociative electron attachment to $(HBr)_2$ may occur. In addition, it is necessary to postulate the production of Br^- by various charge-transfer processes, followed by the reaction of Br^- with HBr. Analysis of the infrared spectra of $BrHBr^-$ and of $BrDBr^-$ indicates that the vibrational potential function must include significant contributions from both cubic and quartic terms. (auth)

1849 MASS-SPECTROMETERIC STUDY OF THE KINETICS OF D_5^+ FORMATION. Arifov, U. A.; Pozharov, S. L.; Chernov, I. G.; Mukhamediev, Z. A. (Inst. of Nuclear Physics, Tashkent). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 1, 79-80(Jan-Feb 1971).

Translated from Khim. Vys. Energ.; 5: No. 1, 90-1(Jan-Feb 1971).

In a continuation of studies concerning ionic–molecular reactions in hydrogen the heat of formation (ΔH) of D_3^+ was calculated. After taking into consideration the errors in determining the values for both hydrogen and deuterium it was concluded that the heat of formation of D_3^+ is higher than that of H_3^+. (D.H.M.)

1850 TRITIUM EXCHANGE BETWEEN HYDROCARBONS AND STEAM. Frink, Robert O.; Wethington, John A. Jr. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc.; 14: No. 2, 467-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1851 ORTHOHYDROGEN–PARAHYDROGEN CONVERSION AND HYDROGEN–DEUTERIUM EQUILIBRATION ON SODIUM TUNGSTEN BRONZES. Jones, F. T.; Loebl, E. M. (Polytechnic Inst. of Brooklyn). J. Phys. Chem.; 73: No. 4, 894-9(Apr 1969).

The parahydrogen conversion and H_2-D_2 equilibration were studied as a function of temperature and pressure on sodium tungsten bronzes of composition between $Na_{0.36}WO_3$ and $Na_{0.98}WO_3$. Conversion but not H_2-D_2 equilibration was observed at 77°K, indicating that conversion at low temperatures occurs by a magnetic mechanism. Both conversion and equilibration were observed at temperatures above 273°K. The results are best explained by a dissociative-adsorption mechanism over the pressure range 15 to 370 torr. The pressure dependence of the rate constants, together with the equilibrium exchange of deuterium with a hydrogenated surface, indicate that the reaction occurs on sparsely separated regions of high local activity. In the region 273 to 473°K, E_a = 6.8 ± 0.2 kcal/mole for the conversion on all of the cubic bronzes, but the Arrhenius preexponential factor shows a maximum at $Na_{0.7}WO_3$ similar to the maximum observed in the electrical conductivity for randomly selected crystals. (auth)

1852 PHOTOLYSIS OF HYDROGEN SULFIDE. EFFECT OF ADDED INERT GASES. Dzantiev, B. G.; Shimchuk, O. S.; Shishkov, A. V. (Inst. of Chemical Physics, Moscow). This paper was summarized in Khim. Vys. Energ.; 4: No. 4, 361 (Jul-Aug 1970). (In Russian).

Full copy of this paper is held by DTIE.

In order to confirm directly the participation of hot hydrogen atoms in reactions, the photolysis of mixtures of hydrogen sulfide with ethylene in the presence of moderators was carried out. The moderators used were argon, helium, carbon dioxide, nitrogen, C_2H_6, and C_2D_6. The introduction of moderators leads to a decrease in the average kinetic energy of the hot hydrogen atoms, which should be reflected in their reactivity and thereby on the values of the ratios of effective rate constants measured experimentally. The experiments carried out made possible a quantitative evaluation of the efficiency of the different thermalizing additives. If the moderating efficiency of helium is taken as unity, the values for the other gases are: N_2 0.058, CO_2 0.076, C_2H_6 0.0045, C_2D_6 0.0012. The different moderating effects of the normal and completely deuterated ethanes require special consideration. (auth)

1853 HYDROGEN DIBROMIDE RADICAL: INFRARED DETECTION THROUGH THE MATRIX ISOLATION TECHNIQUE. Bondybey, Vladimir (Univ. of California, Berkeley); Pimentel, George C.; Noble, Paul N. J. Chem. Phys.; 55: No. 2, 540-5(15 Jul 1971).

When hydrogen bromide–bromine–argon mixtures are passed through a flow discharge and the products are condensed at 20°K, prominent absorptions appear at 727.4, 892.1, and 1053.0 cm^{-1}. With deuterium, these features shift to 496.1, 666, and 833 cm^{-1}. Both deuterium and bromine isotope shifts show that these features can be assigned to the BrHBr (BrDBr) free radical in a linear, symmetric ($D_{\infty h}$) structure with ν_3 = 727.4 (496.1) cm^{-1} and ν_1 = 164.7 (170) cm^{-1}. The evidence that these bands are not due to HBr_2^- is reviewed. The vibrational potential function for ν_3 includes a large quartic term and it suggests that the hydrogen bond in HBr_2 is comparable in strength to that in HBr_2^-. (auth)

1854 ION-MOLECULE REACTIONS OF CH_4–CD_4 MIXTURES AT HIGH PRESSURES. Chong, Shuang-ling; Franklin, J. L. (Rice Univ., Houston, Tex.). J. Chem. Phys.; 55: No. 2, 641-6 (15 Jul 1971).

Ion–molecule reactions in mixtures of CH_4 and CD_4 at pressures up to about 0.65 torr were carried out in a single ion source of a quadrupole mass filter. From the isotope distribution in the ethyl ions, it is evident that randomization occurs in the complex of methyl ions with methane. There is no evidence for reaction of ethyl ion with methane. Similarly, methane ions react with methane to form CH_5^+, CH_4D^+, CD_4H^+, and CD_5^+. The ratios of products are very nearly what would be expected from reactions of methane ion with methane rather than from transfer of protons and deuterons from methanium ion. H and D atoms appear to be transferred at equal rates but deuterons are transferred at only about six-tenths the rate of transfer of protons. (auth)

1855 MAGNETIC ROTATION SPECTRA OF THE A $^2\Sigma^+$–X $^2\Pi_i$ TRANSITION OF OH AND OD. Nanes, R.; Robinson, D. W.

(Johns Hopkins Univ., Baltimore). J. Chem. Phys.; 55: No. 2, 963-74(15 Jul 1971).

The magnetic rotation spectrum of the (0,0) band of the $A\ ^2\Sigma^+ - X\ ^2\Pi_i$ transition of OH (3064 Å) and OD (3065 Å) was photographed at high resolution along with the Zeeman and zero-field absorption spectra. All twelve branches of both bands appeared with measurable intensities for the two magnetic fields used, 1300 and 2700 G. In each band the P_1 and Q_1 branches were the most intense, requiring only minutes of exposure compared to the four hours necessary for some weak branches. Several of the MRS lines (particularly in the OD spectra) revealed multiple structure where the individual Zeeman components appear unresolved in absorption. Interpretation was achieved by a computer-aided synthesis of the spectra. Calculations were based on the classical formulas for the dispersion of the refractive index and absorption coefficient near resonance, and thus included the effects of both magnetic optical rotation and circular dichroism. After corrections for instrumental broadening, the calculations gave good agreement with experiment. (auth)

1856 ANISOTROPIC INTERMOLECULAR FORCE EFFECTS IN SPECTRA OF H_2- AND D_2 RARE-GAS COMPLEXES. McKellar, A. R. W.; Welsh, H. L. (Univ. of Toronto). J. Chem. Phys.; 55: No. 2, 595-9(15 Jul 1971).

Spectra of H_2-Ar, H_2-Kr, and H_2-Xe Van der Waals complexes accompanying the $Q_1(0)$, $S_1(0)$, $Q_1(1)$, and $S_1(1)$ transitions of the pressure-induced fundamental absorption band of hydrogen, were studied in a path length of 165 m at temperatures in the range 85 to 158°K. At the low total gas densities used, 1–2 amagat, the lifetimes of the complexes were sufficiently long to show a great deal of new detail in the spectra. The R and P branches ($\Delta l = \pm 1$, where l is the angular momentum of the complex) accompanying the overlap-induced $Q_1(0)$ transitions, could be analyzed on a nonrigid rotation model to give Lennard–Jones ϵ and σ parameters for the molecular pairs. The spectra accompanying the quadrupole-induced $S_1(0)$, $Q_1(1)$, and $S_1(1)$ transitions show T and N ($\Delta l = \pm 3$) as well as P and R branches, and many of the lines are split by the anisotropy of the intermolecular forces. The splitting is qualitatively in agreement with a model with loose coupling between J, the angular momentum of the H_2 molecule, and l. Well-resolved spectra of D_2-Ar, D_2-Kr, and D_2-Xe complexes accompanying the $S_1(0)$ transition of deuterium were also obtained; these show more bound states than the H_2–rare-gas spectra and anisotropic interaction effects are evident. The H_2-N_2 complex shows a spectrum with a diffuse structure not previously observed. (auth)

Physical Chemistry

Refer also to abstracts 2527, 2605, 2627, and 2631.

1857 OCTAHEDRAL CHLORIDE COMPLEXES OF TRIVALENT ACTINIDES AND LANTHANIDES IN SOLUTION. Marcus, Y.; Bomse, M. (Hebrew Univ., Jerusalem). Israel J. Chem.; 8: No. 6, 901-11(1970).

The preparation of the crystalline octahedral complex tris(triphenylphosphonium) hexachloroamericate(III) is reported. The absorption spectra of the octahedral hexachloro complexes of curium(III), americium(III), and most of the trivalent lanthanides in a nitrile solvent are also reported. The dissociation of the hexachloro-americate complex anion in the nitrile solvent and in propylene carbonate has been examined. The stepwise association constant K_6 for its formation from the pentachloro complex was found to be 150 ± 20 and 60 ± 20 in 85% vol succinonitrile 15% acetonitrile solvent and in propylene carbonate respectively. (auth)

1858 SYSTEMS U–S AND U–Se. Ellert, G. V.; Slovyanskikh, V. K.; Sevast'yanov, V. G. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim.; 16: No. 6, 1721-4 (Jun 1971). (In Russian).

The U–S system and the U–Se system were studied in the region 65 to 100 atom % of the nonmetal, constructing the binary diagrams from differential-thermal, x-ray, and chemical analytical data. The compounds $US_{1.87}$ and $USe_{1.88}$ were found to exist. The compounds US_2 and USe_2 had two polymorphic monotropic modifications; the β-forms were stable, and the γ-forms were metastable. The chemical composition of uranium sulfide as a function of temperature was studied up to 1150°C at constant sulfur pressure. (tr-auth)

1859 DETERMINATION OF STABILITY CONSTANTS OF SOME BIVALENT METAL COMPLEXES WITH 2-HYDROXY-5-METHYL-ACETOPHENONE, -PROPIOPHENONE, AND -BUTYROPHENONE. Prakash, Shri; Dutt, Yag; Singh, R. P. (Univ. of Delhi). Indian J. Chem.; 9: No. 2, 165-7(Feb 1971).

Stability constants of the complexes of some bivalent metals, Cu^{2+}, Ni^{2+}, Co^{2+}, UO_2^{2+}, Zn^{2+}, and Mn^{2+}, with 2′-hydroxy-5′-methylacetophenone, 2′-hydroxy-5′-methylpropiophenone and 2′-hydroxy-5′-methylbutyrophenone were determined potentiometrically in 50% dioxane and 0.1 M sodium perchlorate medium. The order of stability constants for the complexes was found to be: Mn < Co < Ni < Cu > Zn in agreement with the Irving–Williams order of stability of bivalent metal complexes. The relative stability of complexes with different ligands is rationalized. (auth)

1860 COMPLEX NITRATES OF THORIUM. Molodkin, A. K.; Belyakova, Z. V.; Ivanova, O. M. Zh. Neorg. Khim.; 16: No. 6, 1582-9(Jun 1971). (In Russian).

The following complex thorium nitrates were synthesized: $Th(NO_3)_4 \cdot 4H_2O$, $Th(NO_3)_4 \cdot 5H_2O$, $NaTh(NO_3)_5 \cdot 8.5H_2O$, $KTh(NO_3)_5 \cdot 6H_2O$, $Rb_2Th(NO_3)_6$, $Cs_2Th(NO_3)_6$, $MeTh(NO_3)_6 \cdot 8H_2O$ where Me = Mg^{2+}, Co^{2+}, Ni^{2+}, Mn^{2+}, $K_3Th(NO_3)_7$, and $K_3(H_3O)_3[Th(NO_3)_{10}] \cdot H_2O$. The density, refractive index, molar conductivity, and pH of aqueous and methanol solutions were measured. The thermal decomposition of these compounds was also studied. (K.S.W.)

1861 THERMODYNAMICS OF STRUCTURAL CHANGES OF WATER DURING THE DISSOLUTION OF HALIDES OF THE RARE EARTH AND ACTINIDE ELEMENTS. Krestov, G. A.; Egorova, I. V. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 879-80(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 903-4(Nov-Dec 1970).

The entropy characteristics, $\Delta\Sigma(\Delta S_{II})$ and $\Delta\Sigma(\Delta S_{near})$, of the structural changes of water in the dissolution of halides of the rare earth and actinide elements were calculated. It was shown that these changes have a significant influence on the dissolution process and counteract the dissolution of halides of the rare earth and actinide elements in water. Patterns in the variation of the indicated entropy characteristics were noted, and an interpretation of them was cited. (auth)

1862 MOLECULAR ORBITAL DESCRIPTION OF TcH_9^{2-}. Basch, Harold; Ginsberg, A. P. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Phys. Chem.; 73: No. 4, 854-7(Apr 1969).

A ground-state molecular orbital wave function was calculated for the TcH_9^{2-} ion within the full, nonempirical Hartree–Fock–Roothaan formalism in a large gaussian orbital basis. The computed MO's are used to calculate net charges on the atoms, the absolute magnetic shielding at the protons, and the anisotropy in the strictly diamagnetic part of the bulk susceptibility. The calculated shielding is in satisfactory agreement with the experimental value. It is concluded that the hydrogens in TcH_9^{2-} are almost identical in regard to their electronic environment. The lowest lying band positions, polarizations, and intensities in the electronic absorption spectrum are estimated. (auth)

1863 ELECTRON-TRANSFER SPECTRA AND THE II–III OXIDATION POTENTIALS OF SOME LANTHANIDE AND ACTINIDE HALIDES IN SOLUTION. Nugent, L. J.; Baybarz, R. D.; Burnett, J. L. (Oak Ridge National Lab., Tenn.). J. Phys. Chem.; 73: No. 4, 1177-8(Apr 1969).

New information consistent with recent chemical work on the II–III oxidation potentials of some of the lanthanide and transplutonium elements is presented that indicates that a linear Barnes and Day type of lanthanide calibration plot shifted by +0.8 V can be applied to the transplutonium series, and it substantiates Jørgensen's spin-pairing energy treatment of electron-transfer spectra and related oxidation potentials. (D.H.M.)

1864 INTRAMOLECULAR ENERGY TRANSFER AND SENSITIZED LUMINESCENCE IN ACTINIDE(III) β-DIKETONE CHELATES. Nugent, L. J.; Burnett, J. L.; Baybarz, R. D.; (and others) (Oak Ridge National Lab., Tenn.). J. Phys. Chem.; 73: No. 5, 1540-9(May 1969).

Survey experiments were performed to determine whether uv-excited sharp-line sensitized luminescence (SLSL) could be detected and studied in some α-active actinide (An^{3+}) β-diketones, namely, the hexafluoroacetylacetonate chelates $CsAn(HFA)_4 \cdot nH_2O$ with the An^{3+} ions $^{241}Am^{3+}$, $^{243}Am^{3+}$, $^{244}Cm^{3+}$, $^{249}Bk^{3+}$, $^{249}Cf^{3+}$, and $^{253}Es^{3+}$. The relatively heavy HFA^- ligand was chosen as the chelating agent so the work could be performed effectively at room temperature. Measurements were made on the pure crystals $CsAn(HFA)_4 \cdot H_2O$ only in the Am^{3+} and Cm^{3+} cases, on the chelates in anhydrous ethanol solutions in all cases, and with An^{3+} as a dopant in the $CsGd(HFA)_4$ crystal matrix in all cases. SLSL was detected only in the case of Cm^{3+}; it is highly efficient in all three media, resembling Eu^{3+} in red SLSL color and in high quantum efficiency. The results indicate that laser emission could be demonstrated in certain Cm^{3+}-chelate solutions. The absence of SLSL over the 4000 to 10,200-Å experimental range in the case of Es^{3+} suggests that the first excited state of this $5f^{10}$ electronic configuration is below 9800 cm^{-1}. Measurements of self-excited luminescence of the crystalline $Cs^{244}Cm(HFA)_4 \cdot H_2O$ show that it

is essentially the same as the uv-excited luminescence and that the radiolytic decomposition is linear with a total decomposition time of 6 hr. This is approximately the time required for the time-integrated molar radioheat to equal the sum of the molar bond energies and crystal binding energy. Evidently the individual ligands are excited by the α activity and the energy is transferred via the ligand singlet and/or triplet state to the Cm^{3+}, as it is with uv excitation. Estimates are made of the radiolysis lifetime for each sample studied, assuming the radiolytic decomposition is in each case linear in time and that the decomposition rate is proportional to the specific radioheat of the isotope under consideration. These results indicate that radiolytic decomposition over the time required to do the experiments is not responsible for the absence of SLSL in the Am^{3+}, Bk^{3+}, Cf^{3+}, and Es^{3+} cases. (auth)

1865 LIQUID–VAPOR EQUILIBRIUM IN THE SYSTEM H_2O–HNO_3–$UO_2(NO_3)_2$ AT PRESSURES OF 180, 360, AND 720 mm Hg. Efimov, A. N.; Zhikharev, M. I.; Zhirnov, Yu. P. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 732-4(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 766-8(Sep-Oct 1970).

The liquid–vapor equilibrium was studied in the system H_2O–HNO_3–$UO_2(NO_3)_2$ at pressures of 180, 360, and 721 mm Hg. It was established that the dependence of the composition of the vapor on the pressure can be represented in the form of straight lines in Othmer coordinates. The principle of mutual salting out was formulated. (auth)

Radiation and Nuclear Chemistry

1866 (NYO-3383-19) ROLE OF STRUCTURE AND ENERGY (OR IONIZATION) TRANSFER IN RADIATION CHEMISTRY AND BIOLOGY. Progress Report, June 9, 1970–June 2, 1971. Trumbore, Conrad N. (Delaware Univ., Newark. Dept. of Chemistry). Contract AT(30-1)-3383. 14p. Dep. NTIS.

New evidence of an important role for water structure in aqueous radiation chemistry is presented. Pulse radiolysis studies are reported in which very small concentrations of inert salts, some as low as 10^{-9} M, control the decay rate of hydrated electrons, many times as concentrated as the salt. These results are interpreted in terms of structure-making and structure-breaking effects of the aqueous ions which may be exhibited for very short periods of time ($\sim 10^{-11}$ sec). A transient intermediate, tentatively designated as H_2O^+, is proposed to exist in structured regions of water and to react with the hydrated electron ten times as fast as normal diffusion limited reactions. The implications of this theory for radiation biology are discussed. The remarkably wide range of radiation resistance in the blue-green algae appears to depend on an induction of episomes or a derepression controlled by contaminants intimately involved in cellular metabolism. Investigation into the nature of these contaminants reveals a complex fungal-like association in many respects similar to chytrid algal parasites. Gamma irradiation appears to activate the spores of these contaminants, upsetting the ordinary symbiotic relation. Studies of blue-green algal/host relationships in a large number of algae (Schizothrix calcicola) and viruses are reported in terms of host range and plaque morphology. Abundant evidence for lysogeny, defective phage, and transduction in the blue-green algae has been found. Applications and ecological implications of these results are described. (auth)

Radiation Effects

Refer also to abstract 2654.

1867 RADIATION STABILITY OF AN-25 AND AN-25A ANION-EXCHANGE RESINS. Kiseleva, E. D.; Chmutov, K. V.; Khasanova, V. M.; Markova, Z. A. (Inst. of Physical Chemistry, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 4, 499-502(Apr 1971).

Translated from Zh. Fiz. Khim.; 45: No. 4, 897-902(Apr 1971).

The changes in the structure of AN-25 and AN-25A anion-exchange resins on irradiation with a stream of accelerated electrons were investigated by infrared spectroscopy and potentiometric titration. It was established that irradiation leads to radioinduced oxidation with formation of carboxy, phenolic, and hydroxy groups. (auth)

1868 RADIATION TRANSFORMATIONS OF THE EXCHANGE GROUPS OF ANION-EXCHANGE RESINS. Roginskaya, B. S.; Bychkov, N. V.; Kasperovich, A. I. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 2, 171-2(Mar-Apr 1969). (In Russian).

Full copy of this paper is held by DTIE.

The anion-exchange resins AV-17 (6,8,16% divinylbenzene), AV-57, AN-18, AN-21, and AN-22 were irradiated by the γ-rays of ^{60}Co in the presence of water. From the data obtained it follows that the decomposition of the quaternary ammonium groups of styrenedivinylbenzene anion-exchange resins up to the dose 4×10^5 rad proceeds according to the type of the Hofmann reaction. Beginning with a dose of 4×10^5 rad, when less than 18% strongly basic groups remain in the anion-exchange resin, while the amount of weakly basic groups is increased to 13 to 30% of the initial capacity, the amount of nitrogen in the anion-exchange resin exceeds its exchange capacity, i.e., "inactive" nitrogen appears in the anion-exchange resin. To determine the role of the weakly basic groups in the formation of "inactive" nitrogen the weakly basic anion-exchange resins AN-21 and AN-22, containing secondary and tertiary amino-groups, and the anion-exchange resins AN-18 and AV-17 (preliminarily heated in water for 300 hr at the temperature 125°C), containing chiefly tertiary aminogroups, were irradiated. A comparison of the data obtained shows that the tertiary amino-groups present in the irradiated and heat-treated anion-exchange resin AV-17 and in the anion-exchange resin AN-18 are the sources of the formation of "inactive" nitrogen. In anion-exchange resins containing only primary and secondary amino-groups, no "inactive" nitrogen is formed. (D.H.M.)

1869 COMPARATIVE DATA ON RADIATION STABILITY OF SOVIET ION-EXCHANGE MEMBRANES. Tulupov, P. E.; Greben, V. P.; Kasperovich, A. I. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 3, 274(May-Jun 1969). (In Russian).

Full copy of this paper is held by DTIE.

The following sulfocationic homogeneous membranes were investigated: Ankalit K-2 based on styrene and formaldehyde, Ankalit K-2-OP containing a plasticizer, MK-100 based on styrene grafted on polyethylene, and MPFS based on styrene grafted on fluoropolymeric films; anionic homogeneous membrane MA-100 based on styrene grafted on polyethylene, containing trimethylammonium functional groups; and heterogeneous membranes, MK-40 and MA-40. The membranes, in the salt form, were irradiated by γ-generator ^{60}Co to doses of 80, 100, and 200 Mrad. The relative capacity losses increased in the order: Ankalit K-2 = Ankalit K-2-OP (approx.) < MPFS < MA-40 < MA-100 < MK-100. Thus, for instance, when the dose was 200 Mrad, the membranes (in the same order) lost 15, 14, 34, 39, 44, and 58% of the total capacity respectively. During the irradiation of all the membranes, destruction of the macromolecules took place resulting in an increase in the equivalent coefficient of moisture absorption and decrease in the mechanical strength. The destruction of the macromolecules was especially pronounced in membranes MK-100 and MPFS. The electric resistance of the irradiated cationic membrane changed but little, whereas in anion exchange membranes MA-40 and MA-100 at 200 Mrad, changes reached 230 and 200%, respectively. (D.H.M.)

1870 ELECTROCHEMICAL OXIDATION IN SOLUTIONS OF URANYL SULFATE AND SULFURIC ACID UNDER THE ACTION OF γ-RADIATION. Kalmykov, L. Z.; Vasil'ev, A. G.; Vail, E. I. (Kharkov Scientific Research Inst. of Medical Radiology. Inst. of Chemical Physics, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 2, 175-7(Mar-Apr 1969). (In Russian).

Full copy of this paper is held by DTIE.

Data are cited on electrochemical oxidation in irradiated solutions of H_2SO_4 and acid solutions of UO_2SO_4, on the basis of which the possibilities of using the indicated systems for the electrochemical determination of the dose rate can be evaluated. Results show that in 2.5×10^{-3} and 2.5×10^{-4} M solutions of UO_2SO_4 when dose rate $P > 500$ to 600 R/sec, linearity is disturbed, which may be associated with a lag of the rate of electrochemical oxidation behind the rate of radiolysis, as well as with the interaction of H_2O_2 and U(IV) in the volume of the solution. No significant differences of the slopes of the straight lines as a function of the UO_2SO_4 concentration were found. Consequently, in this case, just as in solutions of H_2SO_4, the summary radiation chemical yield (G) of the products oxidized at the anode does not depend on the concentration within the investigated range of its variation. The differences of the values cited are statistically significant. In the solutions studied no dependence was found of current strength on the adsorbed dose within a wide range. (D.H.M.)

1871 UNSTABLE INTERMEDIATES. PART XCVII. ELECTRON SPIN RESONANCE SPECTRA AND STRUCTURES OF RADICALS IN γ-IRRADIATED ALUMINIUM ALKYLS, TRIALKYL PHOSPHINES, AND ALKYLPHOSPHONIUM SALTS. Begum, A.; Lyons, A. R.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 14, 2388-92(1971).

Radicals of type R_2C-X (R = H or alkyl, X = alkyl-substituted Al or P) were identified in the title systems. Trends in the magnetic parameters are compared with those for other radicals in

this general class, and it is concluded that in all cases, spin is transmitted to the group X by spin-polarization of the C–X σ-bonding electrons and that the sign of $A_{iso}(X)$ is negative. The weight of evidence is strongly against any significant C–X $d_\pi - p_\pi$ bonding in the ground state of these radicals. (auth)

1872 RADIATION STABILITY OF THE ANION-EXCHANGE RESIN AV-17 IN A MIXED LAYER. Roginskaya, B. S.; Kasperovich, A. I.; Bychkov, N. V. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 2, 170-1(Mar-Apr 1969). (In Russian).

Full copy of this paper is held by DTIE.

Data were obtained on the change in the capacity of a mixed layer under the action of the γ radiation of ^{60}Co up to a dose of 10^9 rad; and an analysis was made of the radiolysis products. The mixed layer consisted of the cation-exchange resin KU-2 in the H-form and the anion-exchange resin AV-17 × 8 in the OH form in a 2 : 2.3 ratio. Samples of the ion-exchange resins were irradiated under a layer of water in hermetic ampoules, and then washed with water and hydrochloric acid. Methylamines, ammonia, and the sulfate ion were determined in the filtrate. During irradiation there are a stratification and a decrease in the volume of the mixed layer. The aqueous extract is colorless; at doses below $6 \cdot 10^8$ rad it is neutral while at higher doses it has an acid pH. During irradiation the sulfo-cation exchange resins lose exchange capacity as a result of the liberation of sulfuric acid. At the beginning of irradiation, the sulfuric acid liberated is entirely absorbed by the anion-exchange resin, while at doses > $6 \cdot 10^8$ rad, the excess of it passes into the water. The total rate of decomposition of the strongly basic groups in the mixed layer is higher than in the separately irradiated anion-exchange resin. (D.H.M.)

1873 RHEOLOGICAL PROPERTIES OF DILUTE AND CONCENTRATED SOLUTIONS OF POLYVINYLCHLORIDE BRANCHED BY IRRADIATION. Palma, G.; Pezzin, G.; Zaramella, S. (CNR, Padua. Montecatini Edison S.p.A., Venezia, Italy). J. Polym. Sci., Part C; No. 33, 23-38(1971).

From seventh microsymposium on macromolecules; Prague (7 Sep 1970).

Following a previous study of two commercial poly(vinyl chloride) polymers (PVC) with M_w values of 130,000 and 70,000, the influence of γ radiation on the concentrated solutions of two other PVC polymers in tetrahydrofuran was investigated. Their M_w values were 51,000 and 700,000, respectively; the second sample being crosslinked by copolymerization with a polyfunctional monomer. The radioinduced changes were investigated by osmometry, light-scattering, gel permeation chromatography and dilute and concentrated solution viscometry. From the experimental data obtained, it can be seen that the viscosity – molecular weight relations are strongly affected by the molecular weight distribution and the presence of branching in the samples. By assuming the Stockmayer distribution, and using the equations developed by Kilb, the viscosities of the irradiated samples were described satisfactorily. (auth)

1874 RADICALS IN ACROLEIN γ-IRRADIATED AT 77°K. Kuleshov, A. P.; Chkheidze, I. I.; Trofimov, V. I. (Inst. of Chemical Physics, Moscow. High Energy Chem. (USSR) (Engl. Transl.); 5 No. 1, 76-8(Jan-Feb 1971).

Translated from Khim. Vys. Energ.; 5: No. 1, 87-9(Jan-Feb 1971).

A comparison of the nature of the radicals formed in the irradiation of solid acrolein and its inclusion compound with urea is presented. In acrolein irradiated at 77°K, a complex EPR spectrum is observed. When the temperature is raised to 180°K, the concentration of radicals decreases, and a quintet of doublets remains in the spectrum with $\Delta H_{qu} \sim 22$ Oe and $\Delta H_d \sim 7$ to 10 Oe, g = 2.003. In the reaction of hydrogen atoms with solid acrolein at 140°K a spectrum of five lines was observed with $\Delta H \sim 22$ Oe, g = 2.003. The EPR spectrum of irradiated acrolein in urea at 77°K represents a quadruplet (two doublets) with splitting 36 and 18 Oe, g = 2.004. In a sample warmed to 170°K, the spectrum takes the form of a triplet with $\Delta H \sim 23$ Oe, g = 2.004. It was concluded that various radicals are formed in the irradiation of acrolein, depending on the matrix. The influence of the matrix on the mechanism of the radical processes should be expected for compounds in which there are no substantially energetically differing processes. (D.H.M.)

1875 PHOTOTRANSFORMATIONS OF FREE RADICALS IN POLYMERS. IV. FORMATION OF PARAMAGNETIC CENTERS IN γ-IRRADIATED POLYMERS SUBJECTED TO IRRADIATION WITH UV LIGHT. Klinshpont, E. R.; Milinchuk, V. K. (Inst. of Physical Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 1, 12-15(Jan-Feb 1971).

Translated from Khim. Vys. Energ.; 5: No. 1, 16-20(Jan-Feb 1971).

New paramagnetic centers, the EPR spectrum of which is a singlet, are observed in a temperature interval of 120 to 200°K upon thawing out of γ-irradiated polyethylene, polypropylene, and poly(vinyl acetate) after treatment with uv light at 77°K. In polyethylene the width of the singlet amounts to 24 Oe with g = 2.0004. An increase in the total concentration of paramagnetic centers is observed in γ-irradiated polyethylene and poly(vinyl acetate) after irradiation with heating. Two possible mechanisms explaining this effect are proposed. (auth)

1876 ION-MOLECULAR CLUSTERIZATION REACTIONS IN WATER VAPOR AT HIGH PRESSURES. Arifov, U. A.; Pozharov, S. L.; Chernov, I. G. (Inst. of Nuclear Physics, Tashkent). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 1, 1-6(Jan-Feb 1971).

Translated from Khim. Vys. Energ.; 5: No. 1, 3-9(Jan-Feb 1971).

The ion–molecular clusterization of water vapor was studied under equilibrium conditions over the pressure range 10 to 40 torr. The ionizing agent used was the β radiation from a zirconium–tritium source. The reaction system is simplified by the dilution technique with an argon diluent. The equilibrium constants for the clusterization reactions are determined and the rate constants for the forward and reverse reactions are determined. The formation of the molecular argon ion in a trimolecular reaction is discussed. The rate constant for this reaction is $(7.0 \pm 1.4) \cdot 10^{-32}$ cm^6/sec. (auth)

1877 ELECTRON SPIN RESONANCE STUDY OF RADIATION-INDUCED CENTERS OF CHEMICAL ACTIVITY IN A SILICA–ALUMINA GEL. Hentz, Robert R.; Wickenden, Dennis K. (Univ. of Notre Dame, Ind.). J. Phys. Chem.; 73: No. 4, 817-22 (Apr 1969).

The ESR spectrum of a γ-irradiated silica–alumina gel has a line 44.5 ± 0.5 G wide at g = 2.0088 ± 0.0005 that is partially resolved into six components separated by 8.5 ± 0.2 G; superimposed on this broad line is a narrow line at g = 2.0010 ± 0.0005. The broad line is identified with a positive hole trapped at an aluminum atom present substitutionally in the silica matrix. The narrow line is attributed to an electron trapped at one of several kinds of oxygen vacancies and seems to result from a reaction of H atoms. An appreciable number of electrons are trapped in such a manner as to be undetectable in the ESR spectrum. At large doses, the positive-hole intensity reaches a limiting value that corresponds to 16×10^{17} spins/g; such a value is comparable with a previously determined value of 13×10^{17} centers/g as the limiting yield of radiation-induced centers of chemical activity. On exposure of irradiated solid to each of 18 reagents and on irradiation in the presence of each of 12 reagents, without exception, behavior of the visible coloration parallels that of the broad ESR signal. With H_2 and H_2O as the only exceptions, a correlation exists between ionization potential of a reagent and its reactivity with the trapped positive holes; such a correlation permits an estimate of the effective electron affinity of the positive hole as lying between 9.8 and 12.1 eV. When present during irradiation, O_2, N_2O, and CO_2 act as traps for free electrons and enhance color and positive-hole signal of the solid; CO and SO_2 apparently act as traps for free positive holes (unstabilized O^-) to give CO_2^- and SO_3^-. A model is presented to describe the generality of results obtained in radiation studies with silica–alumina gel. (auth)

1878 RADIATION STABILITY IN WATER OF AN ANKALITE K-2 ION-EXCHANGE MEMBRANE. Tulupov, P. E.; Greben, V. P. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 4: No. 3, 275(May-Jun 1970). (In Russian).

Full copy of this paper is held by DTIE.

When the K form of an Ankalite K-2 membrane is irradiated in water (dose greater than 200 Mrad), the main products of degradation are HCl and $KHSO_4$. This is shown by the satisfactory agreement of the content of H^+ ions in aqueous extracts and the sum of $[Cl^-]$ and $\frac{1}{2}[SO_4^{2-}]$. The kinetics of the accumulation of $KHSO_4$ and HCl in the irradiation of an Ankalite K-2 membrane obeys a zero-order equation with the constants 7×10^{-4} and 4×10^{-2} mole/kg · Mrad in the dose range from 0 to 200 Mrad and 4.75×10^{-4} and 2.72×10^{-2} mole/kg · Mrad in the dose range from 200 to 1000 Mrad. From the results of elementary analysis, there is no "inactive" sulfur in the irradiated membrane, in contrast to KU-2 cation-exchanger. Its content corresponds to the exchange capacity found at pH 4.5. The change in the moisture capacity coefficient and the loss of weight show that when a membrane is irradiated the predominant processes involve the destruction of the macromolecule and not cross-linking. On irradiation to a dose above 400 Mrad an Ankalite K-2 membrane loses its elasticity and becomes unsuitable for use because of cracking on slight bending. (auth)

1879 INVESTIGATION OF STRUCTURE FORMATION IN ETHYLENE–PROPYLENE RUBBER UNDER THE ACTION OF γ-IRRADIATION. Smetanina, L. B.; Leshchenko, S. S.; Egorova, Z. S.; Karpov, V. L. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 4: No. 3, 274-5(May-Jun 1970). (In Russian).

Full copy of this paper is held by DTIE.

The mechanism of the formation of intermolecular bonds on the irradiation of SKÉP (ethylene–propylene rubber) in vacuum and in an atmosphere of helium was studied. It was shown that when SKÉP is irradiated in vacuum and in an atmosphere of helium the process of radiation cross-linking is the dominant one (ratio of the probability of degradation and the probability of cross-linkage, β/α, for SKÉP with $M_V = 0.48 \times 10^5$ is 0.04 and for SKÉP with $M_V = 0.07 \times 10^5$ it is 0.27). It was calculated that when SKÉP is irradiated in an inert atmosphere the bulk of the intermolecular bonds are formed as a result of the interaction of vinylidene double bonds with polymer radicals. The formation of vinylidene groups in the polymer is probably connected with the destruction of its main chain and, to some extent, with the detachment of hydrogen atoms from two neighboring atoms of carbon in the branches and at the ends of the polymer chain. (auth)

1880 RADIATION-INDUCED EMULSION POLYMERIZATION OF STYRENE. Lukhovitskii, V. I.; Polikarpov, V. V.; Lebedeva, A. M.; Lagucheva, R. M.; Karpov, V. L. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 4: No. 2, 173-4(Mar-Apr 1970). (In Russian).

Full copy of this paper is held by DTIE.

The kinetic characteristics of the radiation-induced emulsion polymerization (REP) of styrene, viz., the variation in the rate of polymerization, the number of particles and the molecular weight with the radiation intensity, the type and concentration of emulsifier, and temperature, as well as the activation energy of the polymerization process were studied. The kinetic relationships were determined by dilatometry and gravimetry. It was found that the molecular weight of polystyrene is lowered with an increase in radiation intensity and temperature. The increase in molecular weight with temperature is explained by the rate of initiation being independent of temperature, while the propagation constant increases with temperature. In the presence of cationic emulsifiers (cetyltrimethylammonium bromide and cetylpyridinium chloride) the kinetic curves had a shape analogous to the kinetic curves obtained in the presence of potassium laurate, but the rate of polymerization was markedly lower (approximately halved). From the relationships obtained for the temperature dependence of the number of particles and rate of polymerization the activation energy for the propagation reaction E = 7700 cal/mole. All the relationships obtained show satisfactory agreement with those predicted by the Smith–Ewart theory. (auth)

1881 ELECTRON SPIN RESONANCE STUDIES OF SINGLE CRYSTALS OF dl-SERINE. I. X IRRADIATION AT 77°K AND 300°K. Castleman, B. W.; Moulton, Grace C. (Florida State Univ., Tallahassee). J. Chem. Phys.; 55: No. 5, 2598-2600 (1 Sep 1971).

The effect of x rays on single crystals of dl-serine, both normal and deuterated, at 77°K and 300°K is reported. When either normal or deuterated dl-serine single crystals are irradiated at 77°K, two radical species are observed. The more intense species is a doublet that is almost isotropic and is the same in both crystals. The doublet was assigned to the negative ion radical $(\cdot COO)CH \times (NH_3)^+CH_2OH$, with the unpaired electron localized primarily on the carboxyl carbon. The other radical species observed was not identified, but is probably the positive ion radical. The ESR spectra from normal and deuterated crystals observed immediately after irradiation at 300°K are the same. After an hour the spectra of the normal dl-serine changed appreciably. (D.H.M.)

Radiation Processes

1882 PROBLEM OF THE RADIATION SULFOCHLORINATION OF PARAFFIN HYDROCARBONS. Dzhagatspanyan, R. V.; Lyaskin, Yu. G. This paper was summarized in Khim. Vys. Energ.; 3: No. 3, 270-1(May-Jun 1969). (In Russian).

Full copy of this paper is held by DTIE.

The results are given of an investigation of the radiation sulfochlorination of soft paraffins in a continuously operating laboratory apparatus. The effect of the power of the γ-irradiation dose from ^{60}Co (P), the specific consumption of the gas mixture (v_g), and the height of the reaction volume (H) on the rate of the process (w_{ox}), and also of its selectivity (j), were investigated. The latter term designates the fraction of the sulfochlorination reaction in the overall substitution process in the hydrocarbons (that is, $j = w_{cx}/w_{ox}$). It was shown that, depending upon the relation of the values P, v_g, and H, the process takes place in the diffusion or in the intermediate region. In the former case, the rate of the process is determined by the value of v_g, and is independent of P and H. With increase in the value of v_g, or reduction in that of P, the process moves over into the intermediate region, within which a clearly defined relation exists between w_{ox} and P. The effect of the dose power and the specific consumption of the gas mixture on the selectivity of the sulfochlorination of soft paraffins were also investigated. The results lead to the conclusion that increase in the value of P causes increase in the selectivity in the immediate region, while in moving to the diffusion region it attains a constant value which is independent of v_g. (D.H.M.)

1883 RADIATIONAL CHLORINATION OF PARAFFINS. IV. CERTAIN MACROSCOPIC REGULAR FEATURES OF THE CHLORINATION OF SOLID PARAFFINS IN CARBON TETRACHLORIDE SOLUTIONS. Dzhagatspanyan, R. V.; Kosorotov, V. I. This paper was summarized in Khim. Vys. Energ.; 3: No. 3, 271-2(May-Jun 1969). (In Russian).

Full copy of this paper is held by DTIE.

Experiments were carried out on paraffin from Grozny, having a melting point of 61.5°C and an average molecular weight of 401, approximately corresponding to the molecular formula $C_{29}H_{60}$. The chlorination was performed in a glass reaction vessel having a capacity of 700 cc, provided with a thermostat jacket, a pocket for thermocouple, a porous Schott filter and a reflux condenser. Chlorinated paraffin was separated from CCl_4 and analyzed for the chlorine content. The final product contained 70 wt % of chlorine. The chlorination rate was the highest during the first stage of the process. In this stage, the process is governed by diffusion, as it does not depend on the radiation dose, but depends on the supply of chlorine. The concentration of the dissolved chlorine is nearly nil. In the final stage, the process is sharply slowed down, and the chemical reaction takes over the control. The reaction rate does not depend any longer on the supply of chlorine, and increases with the increasing intensity of the radiation by a factor of 0.9. The concentration of the dissolved chlorine is near the saturation level. The radiochemical output (of an order of magnitude of 10^4 to 10^5 atoms Cl/100 eV) decreases linearly with the increasing radiation dose in logarithmic coordinates ($G = 4.6 \times 10^5 \cdot P^{-0.75}$ at 50°C). It is not advantageous to carry out the chlorination of paraffin to 70% at a varying supply of the gas. On the basis of the data obtained, it was possible to select optimum conditions for the production of CP-70, and to formulate conclusions about changes in the reactivity of paraffin during its chlorination to a high degree of conversion. (D.H.M.)

1884 RADIATION CHLORINATION OF PARAFFINS. III. INFLUENCE OF THE γ-RADIATION INTENSITY IN THE CHLORINATION OF PARAFFINS ON CERTAIN PARAMETERS OF THE CHEMISORPTION EQUATION. Dzhagatspanyan, R. V.; Kosorotov, V. I.; Kheifets, L. I. This paper was summarized in Khim. Vys. Energ.; 3: No. 2, 173-4(Mar-Apr 1969). (In Russian).

Full copy of this paper is held by DTIE.

Under the condition of a high rate of the chemical reaction of radiation chlorination of paraffin hydrocarbons in the liquid phase, the chlorination process proceeds in the surface layer of the liquid. The kinetics of the process in this case can be described by a second-order differential equation: $D_{Cl_2}(d^2[Cl_2]/dx^2) - k[RH]^{1.5} \cdot P^{0.5} = 0$, which can be solved at the boundary conditions, $X = 0[Cl_2] = [Cl_2]_s$, $X = S[Cl_2] = [Cl_2]_l$, where k is the rate constant of the chemical reaction; [RH] is the concentration of hydrogen atoms being replaced by chlorine; P is the γ-radiation dose rate; X is the coordinate of diffusion; S is the thickness of the diffusion film; $[Cl_2]_s$ and $[Cl_2]_l$ are the concentrations of chlorine on the surface and in the liquid phase; D_{Cl_2} is the diffusion coefficient of chlorine in the liquid. The solution of this differential equation gives an expression for the concentration distribution of chlorine in the diffusion film, the profile of which varies depending on the dose rate. As it is increased, the effective concentration of chlorine in the film is reduced. (D.H.M.)

1885 MORPHOLOGY OF POLYETHYLENE CRYSTALLIZED UNDER THE SIMULTANEOUS INFLUENCE OF PRESSURE AND ORIENTATION IN A CAPILLARY VISCOMETER. Crystal, Richard G. (Xerox Corp., Rochester, N. Y.); Southern, John H. J. Polym. Sci., Part A-2; 9: No. 9, 1641-55 (Sep 1971).

The morphology of high-density polyethylene crystallized under simultaneous pressure and shear in an Instron capillary viscometer were examined by scanning electron microscopy, electron microscopy, and selected-area electron diffraction. Two distinct fibrous morphologies were observed in these unusually transparent strands. The outer sheath was composed of fibers, 3000 Å in diameter, aligned parallel to the extrusion direction and apparently interconnected by a lamellar cross texture. A highly crystalline ribbon texture composed of fine fibers, 200 to 250 Å in diameter, dominated

the inner core. Sharp-spot electron diffraction patterns obtained from these central ribbons indicated a high degree of c-axis orientation parallel to the fibers and an extended-chain crystal structure. The melting behavior of both irradiated and unirradiated strands examined by differential scanning calorimetry was consistent with the formation of two distinct crystalline morphological units. (auth)

1886 POLYMERIZATION OF MONOLAYERS. VI. INFLUENCE OF THE NATURE OF THE EXCHANGEABLE ION ON THE TACTICITY OF INSERTION POLY(METHYL METHACRYLATE). Blumstein, Alexandre; Parikh, Kirit K.; Malhotra, Shadi L.; Blumstein, Rita (Lowell Technological Inst., Mass.). J. Polym. Sci., Part A-2; 9: No. 9, 1681-91 (Sep 1971).

The influence of the nature of exchangeable cations on the tacticity of poly(methyl-methacrylate) (PMMA) prepared from montmorillonite–MMA adsorption complexes (initiated by either free radicals or γ rays) was investigated. The strength of ion-dipole interactions was estimated either by the value of the electrostatic interaction potential or by the value of the carbonyl-stretching frequency shift. It was shown that P_i, the percentage of isotactic triads in the polymer, increases with increasing strength of the ion-dipole interactions, while the persistence ratio and the mean length of closed isotactic (or syndiotactic) sequences remain essentially unchanged regardless of the nature of the cation. It was shown that values of P_i may vary from 0.15 for weakly interacting ions to 0.5 for strongly interacting ones, reaching at the upper limit the value calculated from the model proposed in a previous paper, thus confirming its validity. (auth)

1887 SALT REJECTION BY POLYMER MEMBRANES IN REVERSE OSMOSIS. I. NONIONIC POLYMERS. Yasuda, H.; Lamaze, C. E. (Research Triangle Inst., Research Triangle Park, N. C.). J. Polym. Sci., Part A-2; 9: No. 9, 1537-51 (Sep 1971).

An attempt is made to analyze the relation between salt rejection and water flux of nonionic polymer membranes in reverse osmosis on the basis of the movement of water in the membranes. The membranes studied were cast films and graft films, which were prepared by immersing porous nylon 4 films in glycerol methacrylate solutions and γ-irradiating the sample. The salt rejection R_s is a consequence of transport depletion of salt in relation to water flux. The transport depletion can be quantitatively expressed through knowledge of the mode of water transport and by application of free-volume theory to membrane transport phenomena. Water permeation can be characterized by a parameter $\omega = RTK_1/P_1v_1$, K_1 denoting hydraulic permeability, P_1 diffusive water permeability, v_1 the molar volume of water. Thus polymer membranes can be classified in three categories: $\omega = 1$ (diffusion membranes); $\omega > 1$ (diffusion-flow membranes); and $\omega \gg 1$ (flow membranes). Salt rejection R_s can be expressed in terms of P_1, the diffusive salt permeability P_2, and the effective pressure $(\Delta p - \Delta\pi)$: $R_s = \{\omega + [P_2RT/P_1v_1(\Delta p - \Delta\pi)]\}^{-1}$. Experimental results obtained with various hydrophilic polymers are presented as the dependence of R_s on the logarithm of water flux. Good agreement was found between the experimental data and the calculated curve. Excessive swelling of membranes results in bulk flow of water (high ω) with coupled transport of salt. Hence the salt rejection decreases quickly as water flux increases beyond a threshold value above which water flux can be characterized as bulk flow. (auth)

1888 DEPENDENCE OF THE YIELD OF RADICALS IN CERTAIN SOLID POLYMER SUBSTANCES ON THE DEGREE OF POLYMERIZATION. Makshantsev, B. I. This paper was summarized in Khim. Vys. Energ.; 3: No. 2, 172-3(Mar-Apr 1969). (In Russian).

Full copy of this paper is held by DTIE.

A model of the formation of radicals under the action of ionizing radiation in solid homopolymer substances was proposed, considering the intramolecular migration of energy and applicable to substances with a low degree of polymerization P ($1 \leq P \lesssim 6$). The model permits a determination of the dependence of the yield of radicals in the polymer on the value of P. It is proposed that radicals are formed chiefly directly in the transition of the polymer substance from the highly excited electronic state to electronic states with low excitation. In this case the radiation yield of radicals $G \sim \Gamma_R/\Gamma$, where Γ_R and Γ are the probabilities of transitions per unit time of "high" electronic excitations with and without the formation of a radical, respectively, where it is considered that $\Gamma_R \ll \Gamma$. The values of Γ_R, Γ, and consequently, G as well, generally speaking, depend on the degree of polymerization P. (D.H.M.)

1889 POLY(VINYL CHLORIDE): FORMATION AND PROPERTIES. Seventh Microsymposium on Macromolecules, Prague, September 7–10, 1970. Sedlacek, B. (ed.). J. Polym. Sci., Part C; No. 33, 1-369(1971). (In German and English). (CONF-700972).

Thirty-three papers are included. Two have been abstracted separately for NSA. The remaining papers include a kinetic study of poly(vinyl chloride) in suspension, studies on molecular weight distribution, thermodynamic properties, crystallization, cleavage fracture, creep, long chain branching, thermomechanical degradation of, and reactions on poly(vinyl chloride). Studies are also reported on the polymerization of vinyl chloride. (J.G.B.)

For abstracts of individual papers see: 1873 and 1890.

1890 RADICAL KINETICS IN VACUUM IRRADIATION OF POLY(VINYL CHLORIDE). Bartl, A. (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). J. Polym. Sci., Part C; No. 33, 193-9(1971). (In German).

From seventh microsymposium on macromolecules; Prague (7 Sep 1970).

In the course of the formation of radicals in vacuum irradiated poly(vinyl chloride), a limiting concentration occurs in the temperature range from –196°C to +20°C if a high irradiation dose is applied. The value of the limiting concentration decreases with increasing temperature. This temperature dependence was investigated in detail using electron-spin resonance. When the formerly described results referring to the recombination of radicals within the temperature range from 40°C to 90°C are taken into consideration, the occurrence of a temperature-dependent limiting concentration in the course of the formation of radicals can be explained satisfactorily. (auth)

1891 ROLE OF SURFACE CENTERS IN THE HETEROGENEOUS RADIATIONAL POLYMERIZATION OF ISOBUTYLENE. Shamonina, N. F.; Katov, A. G.; Pshezhetskii, S. Ya. (Inst. of Physical Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 1, 52-6(Jan-Feb 1971).

Translated from Khim. Vys. Energ.; 5: No. 1, 63-8(Jan-Feb 1971).

Study was made of the low-temperature polymerization of isobutylene adsorbed on two types of silica gels and on NaA and CaA zeolites. It has been shown that the initiation of isobutylene polymerization on the surfaces of these adsorbents can involve either stabilized or nonstabilized holes produced by adsorbent irradiation with proton liberation. The effect of the sorbent is to increase the radiational initiation yield from 0.2 to 0.5, the value for the homogeneous phase, to 1.5. Polymerization occurs on the surface, and indirectly in the solid phase. (auth)

1892 INVESTIGATION OF THE PARAMAGNETIC CENTERS AND MOLECULAR MOBILITY IN IRRADIATED ACRYLONITRILE BY EPR. Bol'shakov, A. I.; Mel'nikov, V. P.; Mikhailov, A. I.; Barkalov, I. M.; Gol'danskii, V. I. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 1, 47-51(Jan-Feb 1971).

Translated from Khim. Vys. Energ.; 5: No. 1, 57-62(Jan-Feb 1971).

The EPR spectra of acrylonitrile (AN), free of traces of metastable phases and irradiated at 77°K, were investigated. Analysis of the EPR spectra does not provide a basis for assuming a free-radical mechanism for postpolymerization. The observed sharp decrease in the yield of polymer in the postpolymerization process during the action of light on the irradiated sample speaks in favor of the ionic nature of the initiating act. The average frequency of the reorientation mobility at T = 100 to 180°K [$\nu_{av} \simeq 3 \cdot 10^{11}$ exp $(-2000 \pm 500/RT)$] was estimated from the decrease in the width of an individual component of the EPR spectrum. The kinetic curves of the destruction of the radicals enable one to estimate the frequency of the translational shifts $k_t \simeq 10^{-2}$ sec^{-1} at 118°K. This value is close to the frequency of addition of the monomer to the growing chain ($\tau_p^{-1} \sim k_t$), while $\nu_{av} \sim 10^8$ sec$^{-1} \gg \tau_p^{-1}$. This comparison may indicate that the same type of molecular mobility (apparently translational) is necessary for both postpolymerization and recombination. (auth)

1893 RADIATION-INDUCED GRAFTING OF BUTADIENE TO CHLORINATED POLYETHYLENE AND POLY (VINYL CHLORIDE). Block, Ira; Silverman, Joseph (Univ. of Maryland, College Park). Trans. Amer. Nucl. Soc.; 14: No. 2, 503-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Radiolysis

Refer also to abstract 1864.

1894 (BNWL-SA-4045) IRRADIATION STUDIES OF MONOBASIC SATURATED CARBOXYLIC ACIDS IN NON-CRYSTALLINE HYDROCARBON MATRICES AT 77°K. Bertin, Ernest P.; Burger,

Leland L. (Battelle Pacific Northwest Labs., Richland, Wash.). [nd]. 15p. (CONF-710913-2). Dep. NTIS.

From 162. national meeting of the American Chemical Society; Washington, D. C. (12 Sep 1971).

The hydrocarbons 3-methylpentane and 2-methyl-1-pentene form glassy noncrystalline matrices at 77°K, which are highly suitable for studies in radiation chemistry. The monobasic carboxylic acids were investigated for their ability to attach electrons freed from a system of the two solvents, upon absorption of ^{60}Co gamma rays. Relative electron capture cross sections were determined through competitive electron capture with biphenyl as a reference solute. Decrease in the concentration of solvated electrons, with increasing concentration of acid, is also reported. (auth)

1895 (FRNC-TH-71) PHOTOLYSIS AND RADIOLYSIS OF NITROMETHANE IN THE LIQUID PHASE. Tran-Dinh-Son (Paris Univ. (France). Faculte des Sciences). [nd]. 144p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The properties of nitromethane are reviewed. The experimental methods concerned with the photolysis and radiolysis of nitromethane are described. In particular, a method of purification is discussed. The study of the photolysis of acetone in aqueous solution in the presence of nitromethane led to results which explain the behavior of nitromethane with respect to the methyl radicals coming from the aqueous acetone solution, and account for the low methane yield obtained from the photolysis or radiolysis of nitromethane. These results allowed the ratio of the reaction rates of certain products with the methyl radicals, to be calculated. The study of flash and continuous photolysis of nitromethane in aqueous solution demonstrated that under these conditions, nitromethane decomposes into CH_3 and NO_2. Results from the photolysis of pure nitromethane together with previously obtained information about reaction kinetics, permitted a reaction mechanism to be proposed which interprets coherently all the products observed. The radiolysis of nitromethane at room temperature by γ radiation from ^{60}Co was studied. (France)

1896 (UCLA-12-841) EVIDENCE FOR CROSS-REACTION IN γ-RADIOLYTIC DECARBOXYLATION OF CARBOXYLIC ACIDS IN CONDENSED STATES. Howton, David R.; Wu, Guey-Shuang (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1971]. Contract AT(04-1)-Gen-12. 7p. Dep. NTIS.

In support of an earlier proposal that ejection of an electron from the carboxyl group of a carboxylic acid might lead to decarboxylation of another molecule to which that ionized is H-bonded, ^{60}Co γ-irradiation of the crystalline palmitic–stearic acid "compound" (in which the two substances are cross-paired) yields a pentadecane : heptadecane product mole-ratio greater than unity, in contrast to results obtained when the two acids are self-paired. The data obtained indicate that under the conditions employed, decarboxylation is 13% direct (intramolecular) and 87% crossed (intermolecular). (auth)

1897 INVESTIGATION OF THE RADICAL PRODUCTS OF THE RADIOLYSIS OF SOME POLYFUNCTIONAL MONOMERS OF THE ESTER-TYPE. Dakin, V. I.; Karpov, V. L. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 3, 270(May-Jun 1969). (In Russian).

Full copy of this paper is held by DTIE.

The electronic paramagnetic resonance (EPR) method was used to investigate the radical products of radiolysis at 100°K of certain polyfunctional monomers of the ester-type (the allyl ester of vinylacetic acid, allyl methacrylate, allyl acrylate, ethyleneglycol dimethacrylate, ethyleneglycol diacrylate, and allyl crotonate), and also of certain monofunctional monomers (allyl acetate and methyl methacrylate). The result of the irradiation of an allyl monomer (whether poly- or mono-functional) is to produce the breaking of the C–O bond, splitting off the allyl radical $CH_2=CH-\dot{C}H_2$, apparently because of the dissociative capture of a slow electron by the ester group. On irradiation of a vinyl monomer (whether poly- or mono-functional) the splitting-off of a hydrogen atom from the vinyl group occurs. The radiolysis of allyl–vinyl polyfunctional monomers also leads to the splitting-off of a hydrogen atom from the vinyl group. Variation in the type of the radiolytic process in ester-monomers containing at least one vinyl group coordinated with a carbonyl group from the ester, apparently occurs through change in the distribution of the electronic density within the ether group. Owing to the coordination of the carbonyl group with the double bond of the vinyl group, a reduction occurs in the polarity of the ester substituent, which leads to a reduction in the probability of the dissociative capture of an electron. When the temperature is raised of samples of allyl monomers which have been irradiated at 100°K, the initial allyl radical $CH_2=CH-\dot{C}H_2$ is gradually used up, and the allyl radical $CH_2=CH-\dot{C}H-O-$ accumulates, this being stable at temperatures below the melting point of the monomer. On freezing samples of vinyl and allyl–vinyl monomers irradiated at 100°K, the radicals of the initial type are also consumed, but the products which accumulate are either the radical products of combination with the vinyl group (in the case of vinyl monomers), or the radical products of the combination with the vinyl group and the allyl radicals, $CH_2=\dot{C}H-CH-O$ (in the case of allyl–vinyl monomers). (D.H.M.)

1898 EFFECT OF ELASTOMER MOLECULAR STRUCTURES ON FORMATION OF RADICALS AND COMBINATION PRODUCTS DURING LOW-TEMPERATURE RADIOLYSIS. Kozlov, V. T.; Evseev, A. G.; Karlin, A. V. This paper was summarized in Khim. Vys. Energ.; 3: No. 3, 268-9(May-Jun 1969). (In Russian).

Full copy of this paper is held by DTIE.

Results are presented on the radiation yields of radicals, molecular anions (from alkyl halides), and combination and destruction products, derived from the initial linear sections of rate of buildup curves, with radiation doses ranging from 0 to 121 Mrad. Over this dosage range the buildup curves remain linear for radicals and combination and destruction products. The concentrations of anions, RF^-, reach values close to their maximum at doses as small as 0.1 to 1.0 Mrad. Destruction reduces the yield of combination processes, so the value of G_R was compared with the sum $(G_c + G_d)$, on the assumption that two radicals recombine to form one combination product. Nineteen elastomer compounds were investigated, including saturated and partly unsaturated hydrocarbons, fluorohydrocarbons, and fluorochlorohydrocarbons, polysiloxanes with CH_3, C_2H_5, $CH=CH_2$, C_6H_5, $(CH_2)_3-CN$, $(CH_2)_2-CF_3$ side groups in various combinations and ratios, and arylene siloxanes. The value of G_c or $(G_c + G_d)$ is considerably greater than the value of $G_R/2$. An exception to this was the alkyl halides, for which these values were close, this being probably connected with the high yield of RF^- type anions and reaction of the latter with positive charges stabilized in the system. The neutralization of such centers in the glassy state apparently takes place mainly by an intramolecular mechanism. In the polysiloxanes studied, the values of G_R and G_c depend on the type of substituting group. The values of G_R fall along the series: G_R (alkyl siloxanes) > G_R (allyl siloxanes) > G_R (aryl siloxanes). (D.H.M.)

1899 RADIOLYSIS OF FUMARIC ACID. Glagolev, V. L.; Shamshev, V. N.; Shatrov, V. D. (Inst. of Chemical Physics, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 2, 169(Mar-Apr 1969). (In Russian).

Full copy of this paper is held by DTIE.

The EPR method was used to study the conversion of the intermediate products of the radiolysis of fumaric acid during irradiation with electrons having an energy of 1.6 MeV and heating or illumination of the irradiated specimens. Results were compared with those obtained in a previous study of the radiolysis of succinic acid. (D.H.M.)

1900 INVESTIGATION OF THE MECHANISM OF RADIATIONAL DESTRUCTION OF POLYISOBUTYLENE. Il'icheva, Z. F.; Slovokhotova, N. A. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 3, 273(May-Jun 1969). (In Russian).

Full copy of this paper is held by DTIE.

When polyisobutylene irradiated at a low temperature is warmed, there is an increase in the intensity of the 890 cm^{-1} band which corresponds to vinylidene double bonds, indicating that post-irradiation processes occur comprising disproportionation of free radicals or depolymerization with cleavage of isobutene. (D.H.M.)

1901 EFFECT OF CRYSTALLINE STRUCTURE ON SOME PROPERTIES OF PARAMAGNETIC CENTRES IN IRRADIATED INCLUSION COMPOUNDS OF UREA. Aneli, Dzh. N.; Kitaigorodskii, A. I. (Inst. of Organoelementary Compounds, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 4, 481-3(Apr 1971).

Translated from Zh. Fiz. Khim.; 45: No. 4, 865-8(Apr 1971).

An investigation was made of the behavior of paramagnetic centers in inclusion compounds of urea with sebacic and lauric acids which were irradiated at 77°K. Owing to the vigorous movement of the entrapped molecules, the transformation and the recombination of the paramagnetic centers are more intense in the inclusion compounds than in the irradiated pure acids. (auth)

1902 RADIOLYSIS AND PYROLYSIS OF THE SIMPLEST ORGANOSILICON COMPOUNDS. Meshcheryakov, N. A. (Inst. of Mathematics, Novosibirsk, USSR). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 4, 473-7(Apr 1971).

Translated from Zh. Fiz. Khim.; 45: No. 4, 852-6(Apr 1971).

Experimental results on the radiolysis and pyrolysis of $SiCl_4$ and $GeCl_4$ and compounds of the type $(CH_3)_nSiCl_{4-n}$ are presented. Together with data derived from the analysis of the ESR spectra for the radiolysis and pyrolysis of these compounds, they indi-

cate the formation of neutral and charged radicals. The ESR spectra of the specimens were recorded at different temperatures. (auth)

1903 RADIOLYSIS OF COBALT HEXAMINE NITRATE IN ALKALI HALIDE MATRICES. Srivastava, S. B.; Sarpotdar, A. S.; Shankar, J. (Bhabha Atomic Research Centre, Trombay, India). Indian J. Chem.; 9: No. 2, 144-7(Feb 1971).

The radiolysis of cobalt hexammine nitrate mixed with KCl, KBr, and KI was studied. The value for $G(NO_2^-)$ is maximum for 1:1 compositions. On extrapolation, G (sensitizer) was found to be 1.28, 1.75, and 2.3 for KCl, KBr, and KI respectively, suggesting the order of efficiency as KCl < KBr < KI in these systems. On the other hand, $G(Co^{2+})$ decreases with progressive dilution of the complex and is found to be almost invariant for a fixed degree of dilution irrespective of any matrix employed. For the pure complex $G(Co^{2+} + NO_2^{-*}) = 3.65$, whereas the corresponding values are 1.18, 1.33 for 1:1 KCl and KBr diluted samples respectively, indicating poor utilization of deposited energy in the latter cases. Electrophoretic and mass spectrometric studies revealed similarity of the mode of decomposition of cobalt hexammine nitrate both in the pure and dilute samples. (auth)

1904 THERMOLUMINESCENCE STUDIES IN COBALT CHELATE. Sen Gupta, S.; Sarup, S. (Bhabha Atomic Research Centre, Trombay, India). Indian J. Chem.; 9: No. 2, 171-2 (Feb 1971).

Two thermal glow peaks at ~100 and 200°C were observed in the β^-, γ, and x irradiated complex, sodium hydrogen(ethylenedinitrilo) acetatonitritocobaltate monohydrate $[Na(CoHYNO_2)H_2O]$, showing that the phenomenon of thermoluminescence (TL) is electronic in nature. Thermal neutron irradiation yields an additional peak at 235°C. Doping the sample with Fe^{2+}, Fe^{3+}, and Co^{2+} had no effect on the TL signal whereas doping with water increased the TL signal by a factor of 20 units. Preheating the sample before irradiation also enhances the TL signal. (auth)

1905 STABILITY OF DI(2-ETHYLHEXYL) HYDROGEN PHOSPHATE AGAINST RADIATION. Kuzin, I. A.; Semushin, A. M.; Romanovskii, V. N. (Lensovet Tech. Inst., Leningrad). This paper was summarized in Khim. Vys. Energ.; 3: No. 3, 275-6(May-Jun 1969). (In Russian).

Full copy of this paper is held by DTIE.

The γ radiolysis of di(2-ethylhexyl) hydrogen phosphate (DEHHP) was investigated. Evacuated ampoules with samples of DEHHP and its equimolar mixtures with C_6H_6 and CCl_4 were subjected at room temperature to γ irradiation of an intensity of 0.15 to 0.50 Mrad/hr. The composition of the gas phase was 90% hydrogen, and the remaining 10% consisted of methane, ethane, ethylene, propane, propene, butane, and butene. The liquid products of the radiolysis included mono(2-ethylhexyl) dihydrogen phosphate (MEHHP), orthophosphoric acid, and also some unsaturated compounds. An equimolar addition of benzene had a stabilizing effect, apparently because of the transfer of the stimulating energy from the DEHHP molecules to the C_6H_6 molecules. The destructive effect of CCl_4 may be explained by an increase yield of "hot" radicals resulting from the rupture of CCl_4 and their action on DEHHP molecules. The mechanism of the radiolysis of phosphoric acid esters was investigated by examining free radical products stabilized and recorded by the EPR method in irradiated samples of DEHHP, MEHHP, and tributyl phosphate (TBP). (D.H.M.)

1906 MECHANISM OF RADIATION DESTRUCTION OF POLYMETHYL METHACRYLATE. INVESTIGATION OF THE GASEOUS RADIOLYSIS PRODUCTS. Borovkova, V. A.; Bagdasar'yan, Kh. S. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 2, 174-5(Mar-Apr 1969). (In Russian).

Full copy of this paper is held by DTIE.

The radiation yields, G, of H_2, CO, and CH_4, as well as cleavages of the principal chain of poly(methyl methacrylate) (PMMA) both pure and containing aromatic additives (antirads) were measured. Irradiation was conducted at 300 and 77°K. In the radiolysis of pure PMMA at 300°K it was found that $G = 1.54$, $G(CO) + G(CH_4) = 1.26$. In the presence of antirads the ratio $[G(CO + G(CH_4)]/G$ is substantially greater than one, moreover, the greater the ratio the stronger the protective effect of the antirad. From this it follows that processes leading to the elimination and decomposition of the $COOCH_3$ group without simultaneous cleavage of the principal chain are possible during radiolysis. In radiolysis at 77°K, the radiation yields of H_2, CO, and CH_4, as well as G, are lower than at 300°K. In the presence of antirads, G(CO) and $G(CH_4)$ remain the same as in the absence of the antirad. The dose dependence of G rapidly deviates from a linear function when the dose is increased. Extrapolation to zero dose gives a lower value of G than at 300°K. (D.H.M.)

1907 ELECTRON SPIN RESONANCE OF AN IRRADIATED SINGLE CRYSTAL OF 5-CHLOROURIDINE (γ-RADIATION/CHLORINE RADICAL/α- AND β-PROTONS/NUCLEAR COUPLING). Reiss, Keith W.; Gordy, Walter (Duke Univ., Durham, N. C.). Proc. Nat. Acad. Sci. U. S. A.; 68: No. 9, 2008-10 (Sep 1971).

Electron spin resonance signals from radicals of different types were observed in γ-irradiated 5-chlorouridine. The strongest absorption, a broad resonance with g values ranging from 2.2 to 3.0, must arise from spin density concentrated on chlorine, probably from trapped atoms. However, hyperfine structure expected from Cl nuclei could not be resolved, evidently because of the low symmetry and diversity of the trapping sites and the large anisotropy in the nuclear coupling and g tensor. A very much weaker resonance, which in the single crystal has a resolvable hyperfine structure, was found to be similar to that observed in normal uridine subjected to thermal H atoms. It is concluded that an H atom, probably released by irradiation from the ribose group, replaces the Cl atom on the basic ring to form normal uridine, and that a second H atom later adds to the uridine to form the observed H-addition radical. The differences in the electron spin resonance constants of this radical from those of uridine bombarded with H can be attributed to the proximity of the trapped Cl atoms and to differences in the crystal structure of the chlorouridine from that of normal uridine. (auth)

1908 RADIATION-INDUCED TRANSFORMATIONS IN LIQUID ORGANIC SCINTILLATORS. Gurskii, M. N.; Tsoi, A. N. (Inst. of Nuclear Physics, Tashkent). This paper was summarized in Khim. Vys. Energ.; 3: No. 4, 365(Jul-Aug 1969). (In Russian).

Full copy of this paper is held by DTIE.

The radiation resistance of liquid organic scintillators (LS) and the effects of a luminescent additive (p-terphenyl) on radiolysis of pure aromatic solvents (benzene, toluene, xylene) were studied by the radiophotoluminescence method. Quenching of radioluminescence of the radiolysis products of the solvent was found. In benzene the dose corresponding to a half-drop of the intensity of radioluminescence in the presence of the luminescent additive (1.5×10^{-2}M) varied from 2.8 to 6.1 Mrad. This indicated a decrease of the quenching rate constant by a factor of two. It was found that the absorption spectra of the toluene radiolysis products have a wide maximum and overlap with the luminescence spectrum of the solvent and absorption spectrum of the activator (p-terphenyl). The dependence of the rate of degradation of radioluminescence on concentration of the activator in benzene is presented. An analysis of the results obtained showed that the appearance of radiolysis products in LS significantly changes the conditions of energy transfer from the solvent to the activator. Upon irradiation of LS in the 10^5 to 10^7 rad dose range the drop of radioluminescence with increase of dose is satisfactorily described by the hyperbolic law. (auth)

1909 EFFECT OF METAL IONS ON γ-RADIOLYSIS OF AQUEOUS SOLUTIONS OF GLYCINE. Shagisultanova, G. A.; Il'yukevich, L. A.; Sidorova, I. G. (Belorussian State Univ., Minsk). This paper was summarized in Khim. Vys. Energ.; 3: 364(Jul-Aug 1969). (In Russian).

Full copy of this paper is held by DTIE.

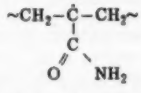
New experimental data were obtained upon γ irradiation (dose 3.2×10^{18} to 1.3×10^{19} eV/ml) of aerated 1×10^{-2} to 1×10^{-1}M aqueous solutions of glycine in the presence of Cu^{2+}, Cu^+, Fe^{2+}, Mn^{2+}, and Co^{2+}. The effects of γ radiation on aqueous solutions of glycine without metal ions were also studied under the same conditions for comparison. The main radiolysis products of glycine in the absence of Me^{n+} are NH_3, CH_3NH_2, and CO_2. Additions of the chlorides of the indicated metals led to complete suppression of deamination processes. The degree of decarboxylation, determined as the CO_2 yield, depended on the type of ion present. It was found that Co^{2+} and Mn^{2+} sensitize and Fe^{2+}, Cu^{2+}, and Cu^+ inhibit decarboxylation of the amino acid. Radiolysis of glycine in the presence of additives accepting water radicals was studied to elucidate the problem of the participation of the radiolysis products of water in transformations examined. It was found that in aerated 0.05M solutions of glycine in the presence of an acceptor of the OH radical (KBr) the formation of NH_3 stops, the content of CH_3NH_2 almost doubles, HCOH appears, and CO_2 is retained. In solutions with $NaNO_3$ (acceptor e^-_{aq} in neutral solutions) NH_3 is also absent, and the yields of CH_3NH_2 and CO_2 in the presence of sodium nitrate and in the glycine solution without acceptors differ little quantatively. The indicated radiolysis products are not formed when HCOONa (H and OH acceptor) is added to the solution before irradiation. The data obtained indicate that both oxidative and reductive radiolysis products of water participate in the decomposition of glycine. The reductive radicals are responsible

for the appearance of methylamine, and the OH radicals for the formation of ammonia. The complete suppression of deamination processes in metal-containing solutions of glycine and the decrease in the degree of deamination in the presence of Fe^{2+}, Cu^{2+}, and Cu^{+} indicate the protective role of metal ions in the radioinduced transformation of glycine. The observed effect can be attributed to complexation of the amino acid with metal ions or to their ability to capture water radicals. The data presented are in good agreement with the concept of complexation. (auth)

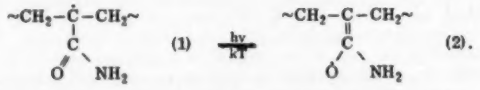
1910 RADIATION CHEMISTRY OF POLYACRYLAMIDE. II. ELECTRONIC SPECTRA AND REACTIONS OF RADICALS IN γ-IRRADIATED POLYACRYLAMIDE. Milinchuk, V. K.; Klinshpont, E. R. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 4, 366-7(Jul-Aug 1969). (In Russian).

Full copy of this paper is held by DTIE.

In polyacrylamide prepared by solid phase polymerization, exposure to γ-radiation at 77°K yielded electronic absorption spectra consisting of three overlapping bands with maxima at λ ~ 260, 295, and 385 nm and EPR spectra consisting of the superposition of a broad line and a quintet with a splitting of ~22 Oe. Exposure to visible light removed the band at λ_{max} = 295 nm and the broad line in the EPR spectrum. Neither the EPR spectrum or the electronic spectra were affected by exposure to uv light. On subsequent heating the five-line spectrum was irreversibly converted into a triplet with a splitting of 26 Oe, while the electronic spectra remained unchanged. On exposure to uv light the triplet is converted to a singlet and the intensities of the bands at $\lambda_{max} \leq 260$ and λ_{max} = 385 nm are decreased. The similar behavior of the EPR spectra and the absorption bands on heating and subsequent irradiation indicated that these bands are due to the free radicals



The changes in the spectra are caused by transormations of the radicals in the reactions



It is assumed that immediately after γ irradiation radicals (1) maintain the conformation of the polymeric chain, in which they are unable to undergo photoconversion. After heating to room temperature the radicals undergo conformational changes, i.e., while remaining nonplanar they acquire the capability for photoconversion. After holding polyacrylamide at 300°K for ~24 h radicals (1) again lose the ability to undergo photoconversion; this is explained by the transformation of these radicals into a planar state. (auth)

1911 INFLUENCE OF THE MOLECULAR WEIGHT OF ALIPHATIC THIOALCOHOLS ON THEIR RADIATION CHEMICAL TRANSFORMATIONS. Nanobashvili, E. M.; Chirakadze, G. G. (Inst. of Inorganic Chemistry and Electrochemistry, Tbilisi, USSR). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 1, 74-5(Jan-Feb 1971).

Translated from Khim. Vys. Energ.; 5: No. 1, 86-7(Jan-Feb 1971).

Results of a study of the influence of molecular weight on the radiation chemical transformations of n-decane-, n-hexadecane-, and n-octanedecanethiols is presented. Data on the decrease in the concentration of sulfhydryl groups in pure thioalcohols as function of the length of the alkyl radical in the RSH molecule show that with increasing molecular weight of C_2-C_{18} thioalcohols, the rate of oxidation of the sulfhydryl groups decreases appreciably during x-radiolysis. (D.H.M.)

1912 EFFECT OF ADDITIVES ON THE RADIOLYSIS OF AMMONIUM PERCHLORATE AND NITRATE. Zakharov, Yu. A.; Bugaenko, L. T.; Nevostruev, V. A. (Tomsk Polytechnic Inst., USSR. Moscow State Univ.). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 1, 57-60(Jan-Feb 1971).

Translated from Khim. Vys. Energ.; 5: No. 1, 69-73(Jan-Feb 1971).

Experimental data are presented to show the effect of mechanically mixing an irradiated salt with NiO, ThO_2, ZnO, or ZnO alloyed with aluminum. By assuming an energy redistribution to result from irradiation of the two component substrate + additive system, an equation was derived to relate the fraction of energy transferred from additive to substrate (α_1), the fraction transferred in the opposite direction (α_2), and the weight fraction (f) of additive in the mixture. Values of α_1 and α_2 for mixtures of ammonium perchlorate and nitrate with ThO_2 and $ZnO(Al_2O_3)$ were obtained by solving this equation graphically. (auth)

1913 PULSE RADIOLYSIS OF LIQUID AMMONIA: OPTICAL ABSORPTION SPECTRUM AND KINETICS OF THE DESTRUCTION OF THE AMMONIATED ELECTRON. Khaikin, G. I.; Zhigunov, V. A.; Dolin, P. I. (Inst. of Electrochemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 1, 44-6(Jan-Feb 1971).

Translated from Khim. Vys. Energ.; 5: No. 1, 54-6(Jan-Feb 1971).

Short-lived optical absorption in the near ir region was detected in liquid ammonia by pulse radiolysis with spectrophotometric recording of the intermediate products. The optical absorption spectrum coincides with the spectrum of the ammoniated electron of metal–ammonia solutions in the investigated spectral range. At −60°C, the absorption band maximum lies at 1420 ± 30 nm, but is shifted to the long-wavelength region with increasing temperature. The radiation yield of the solvated electron at −60°C is 1.2 ± 0.3 particles/100 eV. Analysis of the kinetics of disappearance of the electrons by varying the standardized concentrations showed that the destruction of these particles at −60 to 20°C occurs as the result of bimolecular reactions only. The effective rate constant of these reactions at 213 ± 2°K is 1.6×10^{10} liter/mole · sec. (auth)

1914 STUDY OF CHARGED PARTICLES BY THE PULSE METHOD DURING RADIOLYSIS OF LIQUID HYDROCARBONS. Vannikov, A. V.; Kovalev, V. O.; Zolotarevskii, V. I. (Inst. of Electrochemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 1, 40-3(Jan-Feb 1971).

Translated from Khim. Vys. Energ.; 5: No. 1, 49-53(Jan-Feb 1971).

The pulse method was used for generation and recording of charged particles in liquid hydrocarbons. The direct method was employed to measure the mobilities, recombination constants, and yields of the charged particles that escaped initial recombination as a function of the strength of the constant applied electric field. The dependence of the cumulative charge on the field strength calculated with these measurements taken into account was in good agreement with experimental results over a broad field-variation range (60 to 1.5×10^4 V/cm). (auth)

1915 REACTION BETWEEN ATOMIC HYDROGEN AND SOME SUBSTITUTED BENZENES AT LOW TEMPERATURES. Shatrov, V. D.; Chkheidze, I. I. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 1, 36-9(Jan-Feb 1971).

Translated from Khim. Vys. Energ.; 5: No. 1, 44-8(Jan-Feb 1971).

The reactions between atomic hydrogen and a series of benzene derivatives in the solid phase at −130 to −160°C were studied by EPR. It was shown that a radical of the type C_6H_6-R, which is formed when the hydrogen atom is added to a phenyl ring, is the basic radical reaction product in the cases of toluene, diphenylamine, benzylamine, dimethylaniline, benzonitrile, phenylacetylene, and phenyl isocyanate. Radicals originating when an H atom or OH group is abstracted from the side chain are also formed along with the $C_6H_5^{\cdot}-R$ radicals for mesitylene, phenol, and benzyl alcohol. The data obtained were used to clarify the reactions of H atoms during the low-temperature radiolysis of the benzene derivatives. (auth)

1916 CALCULATION OF THE KINETICS OF RADIOLYSIS OF AMMONIA IN THE GASEOUS PHASE. I. DEPENDENCE OF HYDRAZINE YIELD ON DOSE AND DOSE RATE. Dzantiev, B. G.; Nichipor, G. V. (Inst. of Nuclear Energy, Minsk). This paper was summarized in Khim. Vys. Energ.; 3: No. 4, 367-8 (Jul-Aug 1969). (In Russian).

Full copy of this paper is held by DTIE.

The results of calculations on the kinetics of ammonia radiolysis under a variety of conditions are presented. Basic parameters were: dose rate ($\delta = 10^{10}$ to 10^{20} eV/cm^3 · sec), irradiation time ($\tau = 10^{-3}$ to 10^3 sec), and temperature (T = 300 to 600°K). Data were obtained by means of the Minsk-22 electronic computer. Calculations were performed by the fourth-order Runge–Kutta method on the basis of a radical scheme and the known values of the constants of six elementary reactions; it was assumed that when $\tau > 10^{-3}$ sec all processes with the participation of ions are basically completed. The dependences on τ(D), δ, and T of the absolute and radiation yields (G) of hydrazine and hydrogen were obtained both in the steady and unsteady regions (with respect to radicals and products). It was found that with a change of the irradiation conditions, not only the values of the yields (Hy(mole-

cules), G(molecules/100 eV)) change but also the character of their dependence on the parameters of the process. (auth)

1917 PREDICTION AND INHIBITION OF WATER RADIOLYSIS IN SEALED ALUMINUM CAPSULES. Sheibley, Dean (Plum Brook Station, Sandusky, Ohio). Trans. Amer. Nucl. Soc.; 14: No. 2, 577-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1918 RADIOLYSIS OF ISOPROPANOL IN SUSPENSIONS CONTAINING ZnO. Gurina, T. V.; Egunov, A. V. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 4, 369-70(Jul-Aug 1969). (In Russian).

Full copy of this paper is held by DTIE.

Experimental data on the γ radiolysis of isopropanol in suspensions with ZnO are presented. An investigation of the effect of dose, dose rate, temperature, and the presence of water in the mixtures made it possible to make certain suggestions relative to the mechanism of acetone formation. Thus, the yield of acetone in pure isopropanol is much greater than in its 50% mixture with water (in this case the energy absorbed only by isopropanol was considered when calculating the yield). The acetone yield increases with temperature, but above 50°C decreases markedly. Further, with an increase of the electron contribution of ZnO(ϵ_{ZnO}) the radiation yield of acetone increases linearly from 4 to 5 molecules/100 eV at $\epsilon_{ZnO} = 0$ to 50 to 55 molecules/100 eV at $\epsilon_{ZnO} = 0.6$. A pronounced dependence of acetone yield on radiation intensity was noted at low intensities. The acetone yield is practically independent of intensity at its high values. It is proposed that the mechanism of acetone formation is radiation-catalytic, and an explanation is offered. When a solid absorbs radiation, an active center is formed on its surface where the formation of acetone occurs. The lifetime of this active center is determined, first, by its thermodynamic stability and, second, by the radiation intensity. At a high radiation intensity the probability is quite high that another center will form near the active center, so that their recombination is possible. At low radiation intensities recombination of the active centers will be less likely to occur, and the length of the kinetic chain will be determined mainly by the thermodynamic stability of the active center. The weak dependence of acetone yield on radiation intensity at its high values can apparently be explained by the fact that in this case equilibrium is established between the generation of active centers and their destruction. This equilibrium can be substantially upset at very high radiation intensities (transition into the nonchain region) and at very low, when the thermodynamic stability of the active center will be of decisive importance. Hydrogen peroxide was not detected in the irradiated mixtures (hydrogen peroxide was determined polarographically). Its absence can be explained by the fact that in the presence of a large quantity of ZnO, peroxide can be catalytically decomposed with the formation of oxygen. In this case the independence of the rate of acetone formation on irradiation dose can also be due to regeneration of oxygen in the catalytic reaction of hydrogen peroxide decomposition. (auth)

1919 RADIATION-CHEMICAL TRANSFORMATION OF NUCLEIC ACIDS AND COMPOUNDS MODELING THEM IN AQUEOUS SOLUTIONS. Zakatova, N. V.; Nikonorova, G. K.; Sharpatyi, V. A. (Inst. of Chemical Physics, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 4, 365-6 (Jul-Aug 1969). (In Russian).

Full copy of this paper is held by DTIE.

To estimate the role of water radiolysis products in the presence of radiation damage of biopolymers (RNA, DNA, deoxynucleoprotein (DNP), human serum albumin) and their precursors, the radiolysis of these compounds was studied in the presence of indicator substances. The indicators of the oxidative component of water radiolysis products were p-nitrosodimethylaniline (RNO) and methylene blue (MB), which undergo irreversible bleaching, and of the reductive component, MB (reversible bleaching). The radiation-chemical effects of bleaching of the dyes were recorded by the spectrophotometric method. The dependence of the yield of dye bleaching on the concentration of the investigated substance was studied. The relative rate constants of the reactions of the oxidative component of water radiolysis products were determined. It was found that bases are the most unstable of the nucleic acid components to the effects of OH radicals. Biopolymers, just as their low-molecular-weight components, are acceptors of the oxidative component of water radiolysis. The character of the dependence G(–RNO) on concentration of the investigated substance is the same in both cases. Of the investigated biopolymers, DNA has the greatest reactivity with respect to OH. The presence of protein in DNP evidently protects it against radiation. The reductive components of water radiolysis also participate in the transformation of DNA, which is manifested by a change of $G(H_2)$ in DNA and thymine solutions of different concentrations. (auth)

1920 CALCULATION OF THE KINETICS OF RADIOLYSIS OF AMMONIA IN THE GASEOUS PHASE. III. STEADY YIELD OF HYDRAZINE DURING RADIOLYSIS OF ETHYLENE–AMMONIA MIXTURE. Dzantiev, B. G.; Nichipor, G. V. (Inst. of Nuclear Energy, Minsk). This paper was summarized in Khim. Vys. Energ.; 3: No. 4, 369(Jul-Aug 1969). (In Russian).

Full copy of this paper is held by DTIE.

It is known that the addition of olefins and other substances to ammonia in certain cases increases the radiation yield of hydrazine. This effect was analyzed for the system ammonia–ethylene, and the possible limits of increase of the hydrazine yield were estimated, and the optimal concentration limits were established. Results were obtained by calculation on the Minsk-22 computer by a nonlinear system of eight kinetic equations corresponding to the following elementary radical reactions: $NH_3 \rightsquigarrow NH_2^{\cdot} + H^{\cdot}$; $NH_2^{\cdot} + NH_2^{\cdot} + M = N_2H_4 + M$ (1); $NH_2^{\cdot} + H^{\cdot} + M = NH_2 + M$ (2); $H^{\cdot} + H^{\cdot} + M = H_2 + M$ (3); $H^{\cdot} + N_2H_4 = H_2 + N_2H_3^{\cdot}$ (4); $NH_2 + N_2H_4 = NH_3 + N_2H_3^{\cdot}$ (5); $H^{\cdot} + NH_3 = H_2 + NH_2^{\cdot}$ (6); $H^{\cdot} + C_2H_4 = C_2H_5^{\cdot}$ (7); $NH_2^{\cdot} + C_2H_4 = C^{\cdot}H_2 - CH_2 - NH_2$ (8). The calculation was performed by the Newton method for steady-state conditions and known values of the rate constants and activation energies of the radical reactions (1) through (8) were used. It was found that the steady hydrazine concentration (Hy^{∞}) is an extremal function of the relative concentration of ethylene (α). The increase $Hy_{\infty} = k_1M[NH_2]^2/(k_4[H] + k_5[NH_2])$ in the region $0 < \alpha < \alpha_{max}$ is related with a decrease in the rate of decomposition of hydrazine by $H^{\cdot}$ atoms, as a consequence of the competition of reactions (7) and (4). In this case the time of achieving the steady concentration $\tau_3 = 1/(k_4[H] + k_5[NH_2])$ increases substantially, the time interval in which $Hy \sim \tau$ widens, and the steady concentration Hy^{∞} increases greatly. The presence of a maximum, i.e., decrease of of the hydrazine concentration when $\alpha > \alpha_{max}$, is related with competition of (7) and (8). The optimal concentration $\alpha_{max} = \sqrt{4k_1k_4W_0/k_5k_7k_8(NH_3)}$, where $W_0 = G_0\delta \cdot 10^{-2}$ is the rate of radioinduced decomposition of ammonia. At T = 300°K and $\delta = 10^{14}$ eV/cm^3 sec, $\alpha_{max} \leq 1\%$, which corresponds to the experimental data. With an increase of the dose rate the position of the maximum shifts to the region of larger ethylene concentrations. An increase of temperature leads to a decrease of the effectiveness of ethylene additions (decrease of the maximum). The effect of pressure on the position and value of the maximum is discussed for the cases: (a) dose rate $\delta \sim P$ (γ rays, fast electrons, neutrons); (b) δ does not depend on P (heavy particles, slow electrons). (auth)

1921 CALCULATION OF THE KINETICS OF RADIOLYSIS OF AMMONIA IN THE GASEOUS PHASE. II. DEPENDENCE OF HYDRAZINE YIELD ON TEMPERATURE AND PRESSURE. Dzantiev, B. G.; Nichipor, G. V. (Inst. of Nuclear Energy, Minsk). This paper was summarized in Khim. Vys. Energ.; 3: No. 4, 368(Jul-Aug 1969). (In Russian).

Full copy of this paper is held by DTIE.

Experimental data on ammonia radiolysis were analyzed by calculating the temperature (T) and pressure (P) dependence of the concentration (Hy) and radiation yield (G) of hydrazine, one of the main products of the radioinduced decomposition of NH_3. The calculation was performed by numerical integration of a system of differential kinetic equations on the Minsk-22 computer by the fourth-order Runge–Kutta method. The mechanism involves six radical reactions. The dependence of Hy on T and P was examined in the range of temperatures T = 300 to 600°K and of dose rates $\delta = 10^{10}$ to 10^{20} eV/cm^3 sec and irradiation time $\tau = 10^{-3}$ to 10^3 sec. This interval of τ incorporates the regions of unsteady and steady concentrations of radicals and hydrazine. The character of the temperature dependence Hy = f(T) is different in different regions of τ, δ, and T and is determined mainly by the relationship of the rates (V) and rate constants of certain reactions. Graphs of the dependence $\log (V_6/V_2) = \varphi(\delta, T)$ are presented, and the values of $k_4(H)$ and $k_5(NH_2)$ are tabulated. The dependence Hy = f(T) has an extremal character. The position of the extremes and their value depend on τ and δ. At high δ and relatively low T, when the inequality $V_2 \gg V_6$ (I) holds true, the quasi-steady concentrations of the radical were determined by the expression $(H) = (NH_2) = \sqrt{W_0/3k_1M}$, where $W_0 = 10^{-2}\, G_0\delta$ is the rate of radioinduced decomposition of NH_3 and M is the NH_3 concentration. The steady concentration of [H] and $[NH_2]$ radicals are close to (H) and (NH_2). In the region of T and δ corresponding to when $V_6 \gg V_2$ (II) (small dose rates, high temperatures), $(H) = (W_0/k_6M) \ll (NH_2) = \sqrt{W_0/k_1M}$. It is concluded that with a change of irradiation time, the effective activation energy of the process $NH_3 \rightsquigarrow N_2H_4$ changes. The dependence of the yield of hydrazine and hydrogen on pressure in experiments with light and heavy particles is discussed. (auth)

1922 USE OF TRITIATED H_2S AS A RADICAL SCAVENGER IN THE γ RADIOLYSIS OF ORGANIC LIQUIDS. Pryor, William A.;

Tonellato, Umberto (Louisiana State Univ., Baton Rouge). J. Phys. Chem.; 73: No. 4, 850-3(Apr 1969).

The use of tritiated hydrogen sulfide as a scavenger in the γ radiation of benzene, cyclohexane, and toluene at 27° is reported. The hydrocarbon solvents were recovered and purified, and their activity was determined. In separate experiments, the isotope effect k_H/k_T for the reaction of phenyl and cyclohexyl radicals with thiols was measured. If it is assumed that labeling occurs primarily by radical reactions, then the yield of the tritiated hydrocarbon, G(RH-t), and the isotope effect can be combined to give a value for the yield of the parent-minus-hydrogen radical from these three solvents. The values so obtained agree quite well with literature values using iodine as a scavenger. The method was also evaluated for producing tritium-labeled materials; it gives higher G values for the production of tritiated toluene than does the Wilzbach method and perhaps is somewhat more convenient. (auth)

1923 ELECTRON SCAVENGING IN THE RADIOLYSIS OF CYCLOHEXANE SOLUTIONS OF ALKYL HALIDES. Warman, John M.; Asmus, K.-D.; Schuler, Robert H. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 73: No. 4, 931-9(Apr 1969).

The formation of alkyl radicals in irradiated solutions of CH_3Cl, CH_3Br, and C_2H_5Br in cyclohexane was investigated at concentrations from 10^{-4} to 0.5 M. Experiments with added ethylene and cyclopropane show that the radicals do not result from reactions of either hydrogen atoms or positive ions. From this it appears that radical formation results exclusively from electron capture. The observed concentration dependence can be very well described by the expression

$$G(R_S) = G_{fi} + G_{gi}\frac{\{\alpha_s[S]\}^{\frac{1}{2}}}{1 + \{\alpha_s[S]\}^{\frac{1}{2}}}.$$

The low concentration limit (G_{fi}) is identified with the free-ion yield and is found to be ~0.1. It is believed that the high concentration limit ($G_{fi} + G_{gi}$), which is found to be 3.9 ± 0.1, can be identified with the total yield of electrons available for reaction with solutes. The above expression was used to treat competitive electron capture by two alkyl halides. Deviations from ideality observed in the $CH_3Cl-C_2H_5Br$ system are interpreted in terms of electron transfer from a CH_3Cl anion to the bromide. It is shown that such secondary ionic reactions can be described quantitatively. (auth)

1924 THEORETICAL STUDY OF ALKANE POSITIVE IONS IN γ-IRRADIATED ORGANIC SOLIDS. Narita, K.; Funabashi, K. (Univ. of Notre Dame, Ind.). J. Phys. Chem.; 73: No. 4, 964-8 (Apr 1969).

The nature of optical transitions and the decay of absorption spectra of alkane positive ions in γ-irradiated organic solvents at 77°K are studied theoretically. Absorption maxima for C_7 to C_{16} alkanes are calculated assuming that the optical absorption involves excitation of C–C bonding electrons. Positive charge migration is treated as a phonon-assisted tunneling process and the effective mass of the hole is estimated. (auth)

1925 FAR-ULTRAVIOLET SPECTRA OF HYDROGEN AND HYDROXYL RADICALS FROM PULSE RADIOLYSIS OF AQUEOUS SOLUTIONS. DIRECT MEASUREMENT OF THE RATE OF H + H. Pagsberg, P.; Christensen, H.; Rabani, J.; (and others) (Danish Atomic Energy Commission Research Establishment, Risoe. Aktiebolaget Atomenergi, Studsvik, Sweden). J. Phys. Chem.; 73: No. 4, 1029-38(Apr 1969).

Pulse radiolytic absorption transients were observed in aqueous solutions between 200 and 300 nm using an 11-MeV Linac and an optical detection system that allowed accurate measurements (a) down to 200 nm and (b) 0.2 μsec after the electron pulse. With 10^{-3} M $HClO_4$ + 0.027 M H_2 ($p(H_2) = 35$ atm) transients with second-order decay were observed, which had amplitudes that decayed monotonically in the region from 200 to 240 nm. Assigning these transients to free H atoms, the molar decadic absorptivities ϵ at 200, 210, and 240 nm of H were found to be 900, 560, and 0 M^{-1} cm^{-1}, respectively, and $2k_{H+H} = (1.55 \pm 0.10) \times 10^{10}$ M^{-1} sec^{-1} from measurements at 200 and 210 nm. The transients could be completely quenched by addition of O_2 resulting in a species with the absorption spectrum of HO_2. Furthermore, the transient at 210 nm was not affected when $HClO_4$ was left out of the H_2-saturated solution and N_2O (>2×10^{-3} M) was added instead. The apparent OH transient in 2×10^{-3} M N_2O (no H_2) decayed according to second-order kinetics with a calculated rate constant that after correction for the reaction of H with OH was found to be $(1.04 \pm 0.10) \times 10^{10}$ M^{-1} sec^{-1} independent of the wavelength used. The calculated ϵ for OH showed, after correction for the absorbance of H_2O_2, H, and OH^-, one broad absorption maximum near 230 nm with ϵ 530 M^{-1} cm^{-1} and one below 200 nm. The measurements at 200 nm had to be corrected for a substantial contribution from OH^- to the observed optical absorption. The calculated values of ϵ_H and ϵ_{OH} account quantitatively at all wavelengths used for the initial absorption of the transients in 10^{-3} M $HClO_4$ (no H_2) if it is assumed that H_2O, if formed, decomposes to yield H + H_2O after no longer than 0.2 μsec. The light absorption of aqueous solutions of H and to some extent of OH at 200 nm is attributed to a red shift of the water absorption continuum beginning at 186 nm, caused by a partial electron transfer from the first excited singlet state of water to a neighboring H or OH free radical in analogy with the optical transition associated with the β bands in alkali halide crystals. (auth)

1926 ASPECTS OF THE PULSE RADIOLYSIS AND γ RADIOLYSIS OF ALKYL IODIDES AND THEIR MIXTURES. Capellos, C.; Swallow, A. J. (Imperial Coll. of Science and Tech., London. Christie Hospital and Holt Radium Inst., Manchester, Eng.). J. Phys. Chem.; 73: No. 4, 1077-83(Apr 1969).

Liquid alkyl iodides were subjected to pulse radiolysis and γ radiolysis. A 2-μsec electron pulse produces a broad transient absorption band with a peak near 400 nm, with Gϵ equal to 18,000 26,000, and 34,000 for methyl, ethyl, and isopropyl iodides, respectively. This band disappears in a second-order reaction, and is considered to be mainly due to an iodine atom alkyl iodide charge-transfer complex. Its extinction coefficient at the maximum is 9000 l $mole^{-1}$ cm^{-1} for all three iodides. A weaker and more rapidly decaying absorption is seen in the region 650 to 750 nm attributable to a positively charged species. The band with the peak near 400 nm appears with the same intensity when dissolved oxygen is present, but the decay kinetics are different. In mixtures of methyl and isopropyl iodides its formation is a nonlinear function of composition. In solutions of isopropyl iodide in cyclohexane, the concentration dependence of the band suggests that the charge-transfer complex has its origin partly in an ion-recombination process. Initial yields of iodine and HI were determined for the γ radiolysis of alkyl iodides. The yield of HI falls off rapidly with dose, reaching a plateau at high doses. In mixtures of liquid methyl and isopropyl iodides, the dependence of the iodine and HI yields on composition follows a similar curve to that of the band at 400 nm in the pulse radiolysis. The I_2 and HI yields vary with composition of mixture in quite a different way at −196°C. (auth)

1927 EFFECT OF DENSITY AND ELECTRON SCAVENGERS IN NITROUS OXIDE RADIOLYSIS. Sears, John T. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem.; 73: No. 4, 1143-6 (Apr 1969).

Results are presented for irradiation of solid, liquid, and high-density gas phases using gamma radiation and alpha particles. All the pure N_2O results demonstrated the remarkable relative constancy of $G(N_2)$ (~10 to 11.5). The $G(N_2)$ decreased by only ~$G(\epsilon)$ = 3.05 because of electron scavenging. (M.C.G.)

1928 FREE RADICALS IN POLYAMIDES IRRADIATED WITH FAST NEUTRONS. Biktimirov, R. S.; Kondrat'ev, Yu. A. This paper was summarized in Khim. Vys. Energ.; 4: No. 2, 169(Mar-Apr 1970). (In Russian).

Full copy of this paper is held by DTIE.

Using the EPR method, the free radicals formed during radiolysis of ϵ/caprolactam, Kapron, lithium Kaprolon, sodium Kaprolon, and polyamide resin 68 were studied. The specimens were irradiated at 298°K by a fast-neutron flux (5×10^{14} neutron/cm^2). The EPR spectra were recorded with an RE-1301 radiospectrometer. Irradiation of ϵ-caprolactam leads to formation of radicals with a ~$CH_2-CO-NH-CH-CH_2$~ structure, giving an EPR spectrum of four hfs lines, each of which is apparently split into two components. The EPR spectra of lithium Kaprolon, sodium Kaprolon, Kapron, and polyamide resin 68 consist of six hfs lines. From the character of the EPR spectra of these polymers, it was inferred that ~CH_2~$CO-NH-CH_2-CH-CH_2$~ radicals are formed. It is shown that the resolution of the spectral lines and the intensities of the central components depend both on the temperature at which the spectra are recorded and on the crystallinity of the investigated polymers. (auth)

1929 PICOSECOND PULSE RADIOLYSIS. III. REACTION RATES AND REDUCTION IN YIELDS OF HYDRATED ELECTRONS. Aldrich, J. E.; Bronskill, M. J.; Wolff, R. K.; Hunt, J. W. (Univ. of Toronto). J. Chem. Phys.; 55: No. 2, 530-9(15 Jul 1971).

Rate constants for reactions of the hydrated electron with a wide range of compounds, including simple salts and amino acids, were measured in the time region 20 to 350 psec. In nearly all cases the secondorder rate constant for reaction with the hydrated electron did not change in the concentration range studied. However, the measured rate constant was in general different to that obtained in dilute solutions, and this was attributed to incomplete formation of the ionic atmosphere around the hydrated electron

before reaction. Apart from the hydronium ion, H^+_{aq}, nearly all compounds decreased the initial hydrated electron yield: in all cases this decrease showed an exponential dependence on concentration. Compounds most efficient at decreasing the hydrated electron yield were cystine and cadmium salts, in both cases 0.39 mole/liter being needed to reduce the initial yield to 37%. The ability to reduce the initial yield showed no direct correlation with the corresponding hydrated electron rates. This and other evidence suggest that radiation-produced electrons are reacting before solvation. (auth)

Radioisotope Production

1930 FUTURE PRODUCTION OF ^{238}Pu. Pleat, G. B.; Lindsey, W. J. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 508-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1931 PRODUCTION OF RADIOACTIVE ISOTOPES OF TELLURIUM AND TIN WITHOUT A CARRIER FROM DEUTERON-IRRADIATED ANTIMONY. Iofa, B. Z.; Novikova, N. A.; Sevost'yanov, Yu. G.; Semenov, S. I. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 752-3(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 782-4(Sep-Oct 1970).

A complex method for obtaining a mixture of isotopes of tellurium (^{121}Te, ^{121m}Te, and ^{123m}Te) and tin (^{119m}Sn and ^{121m}Sn) without carriers for deuteron-irradiated antimony is given. The method consists of separating radioactive antimony from tellurium and tin isotopes by extraction from HCl with butyl ether. The radioactive tin is isolated by extraction from solutions of HI with benzene (chloroform or carbon tetrachloride can also be used). The radioactive isotopes of tellurium can be freed of possible impurities by extraction with methyl ethyl ketone from HCl solution. (D.H.M.)

1932 POSSIBILITY OF SEPARATION OF MICROQUANTITIES OF RUBIDIUM FROM MACROQUANTITIES OF STRONTIUM. Zhinka, L.; Sirtesh, L. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 741-4(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 774-8(Sep-Oct 1970).

Microquantities of rubidium can be separated from macroquantities of strontium with good selectivity on the cation exchange resins Dowex-50 and ZP-4 (zirconium phosphate) by elution with solutions of ammonium chloride and hydrochloric acid with ammonium chloride. The use of the cation exchange resin ZP-4 is more convenient in the separation of materials with high radioactivity. The radioisotope ^{84}Rb can be obtained with a relatively good yield in a nuclear reactor in an (n,p) reaction; it can be isolated from the irradiated target in a form free of strontium. (auth)

1933 GENERATOR OF ^{68}Ga. Iofa, B. Z.; Makagonova, L. N. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 770(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 796(Sep-Oct 1970).

A study is reported on a method of preparing a generator and periodic isolation of ^{68}Ga from it without a carrier. The method is based on the fact that Ge(IV) is extracted from HCl solution by carbon tetrachloride, whereas Ga(II) remains almost entirely in HCl solution under these conditions. (D.H.M.)

1934 FORMATION OF ^{67}Cu ACCORDING TO THE REACTION ^{68}Zn(γ,p) ON A RETARDED BEAM OF AN ELECTRON ACCELERATOR WITH AN ENERGY OF 25 MeV. Malinin, A. B.; Kurchatova, L. N.; Litvitskii, A. M.; Abdukayumov, M.; Levin, V. I. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 748-51 (Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 780-2(Sep-Oct 1970).

The formation of ^{67}Cu according to the reaction ^{68}Zn(γ,p) was noted when zinc of the natural isotopic composition was irradiated with the bremsstrahlung of a linear electron accelerator with maximum energy of 25 MeV at a current of 10 μA. The yield of ^{67}Cu in a target 12 mm in diameter and 3 cm high is ~250 μCi. The distribution of the activity of ^{67}Cu through the depth of the target, obeying an exponential law, was investigated. ^{67}Cu was isolated without a carrier from the irradiated target by extraction with a solution of thio-8-hydroxyquinoline in toluene. Only one impurity was detected in the preparation obtained: ^{64}Cu, comprising ~30% of the activity of the time of the end of irradiation. Since the target can be freed of copper by irradiation, the reaction ^{68}Zn(γ,p) can be used to obtain preparations of ^{67}Cu without a carrier, of high radioisotopic purity, on zinc targets of the natural isotopic composition. (auth)

Recoil Production and Reactions

1935 HOT-ATOM CHEMISTRY OF GAS- AND LIQUID-PHASE SYSTEMS. Tominaga, Takeshi (Tokyo Univ.). Radioisotopes (Tokyo); 20: No. 3, 142-9(Mar 1971). (In Japanese).

Review was made on hot atom reaction in liquid phase, reaction between organometallic compounds and recoil tritium, and application of hot atom chemistry in liquid and gaseous phases. The trisacetylacetonatocobalt(III) complex salt, $Co(C_5H_7O_2)_3$, is chemically stable, soluble in various organic solvents, and the hot atom reaction is well studied for the solid phase. This complex salt was dissolved in various solvents, and the hot atom reaction in the liquid phase from the addition of various metallic salts was studied. Reactions between the recoil tritium and tetramethyl compounds of Si, Ge, and Sn were also studied. Hot atom chemistry is a very useful tool in the study of physical chemistry, inorganic chemistry, and organic chemistry because very minute amounts can be traced by particular radioactivity. (Japan)

Radiochemistry

Refer also to abstract 2018.

Separation Processes

Refer also to abstracts 1931, 1932, 1995, 2584, 3747, and 3851.

1936 (BARC/BIB–3) BIBLIOGRAPHY ON PRODUCTION OF HEAVY WATER. Nagrathna, R. A. (comp.) (Bhabha Atomic Research Centre, Bombay (India)). 1970. 54p. INIS.

The production aspects of heavy water are considered and 127 references to reports, journal articles, and other published literature up to Dec. 1970, with informative abstracts, are presented. The references are grouped under the subject headings: (1) General Processes, (2) Distillation Processes, (3) Isotopic-Exchange Processes, and (4) Water-Electrolysis Processes. Within each subject, the material is arranged by author, or, when no personal author is given, by title. Many of the references cited have appeared in Nuclear Science Abstracts, and for these abstracts, the NSA abstract numbers are given. Author, report, and keyword indexes are given at the end of the bibliography. (auth) (INIS)

1937 (CONF-711009–5) SEPARATION OF DAUGHTERS OF ^{232}U FROM ^{233}U BY ION EXCHANGE. Rainey, Robert H.; Nicol, Ralph G. ([Oak Ridge National Lab., Tenn.]). [nd]. 13p. Dep. NTIS.

For Presentation at joint meeting of the American Nuclear Society; Miami, Fla. (17 Oct 1971).

An ion exchange process was developed to remove the daughters of ^{232}U from a solution of ^{233}U, thereby decreasing the gamma activity to a sufficiently low level that kilogram amounts of ^{233}U may be further processed in glove boxes without additional shielding. This process takes advantage of the fact that, under suitable conditions, the longer-lived daughters of ^{232}U are more strongly absorbed by Dowex 50W than is uranium. A large amount of uranium can pass through the resin bed before the ^{228}Th and ^{224}Ra can be detected in the effluent stream. (auth)

1938 (IEA–210) SORPTION OF URANIUM IN URANYL NITRATE SOLUTIONS ON STRONG CATIONIC RESINS AND ITS ELUTION WITH AMMONIUM SULFATE. II. EFFECTS OF EDTA ON THORIUM DECONTAMINATION. Ribas, Antonio G. S.; Abrao, Alcidio (Instituto de Energia Atomica, Sao Paulo (Brazil)). May 1970. 22p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

Studies of the decontamination of thorium present as impurity in uranyl nitrate solutions are described. When the solution was passed through a strong cationic resin the thorium was partially retained. Then, the final decontamination was performed percolating the uranyl solution on a second cationic resin, after complexation of thorium (and other impurities) with EDTA. The thorium decontamination and the uranium retention were studied as functions of the EDTA/U ratio, uranium concentration, and acidity of the influent uranyl nitrate. The elution conditions were also studied as a function of eluent flow rate, concentration, and acidity. (auth)

1939 (ORNL-tr–2522) INFLUENCE OF SULFATE AND MOLYBDENIUM IONS ON THE FORMATION OF ZIRCONIUM BUTYLPHOSPHATES DURING IRRADIATED FUEL REPROCESSING BY THE PUREX PROCESS. Ballet, P.; Kauffman, F.; Miquel, P. (Commissariat a l'Energie Atomique, Fontenay- aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from Sections 7.2-7.4 of report CEA-N-1241. 28p. Dep. NTIS.

An abstract for CEA-N-1241(pp. 179-254), prepared from the original language, appeared as NSA 24: 36339.

1940 ISOTOPE SEPARATION FACTORS IN RADICAL REACTIONS. Basov, Yu. G.; Panchenkov, G. M. (Moscow State Univ.). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 4, 468-9(Apr 1971).

Translated from Zh. Fiz. Khim.; 45: No. 4, 843-4(Apr 1971).

Formulas based on the collision theory are proposed for the calculation of the isotope separation factors in radical reactions. The separation of hydrogen isotopes following the interaction of oxygen and hydrogen in a silent electric discharge is used to illustrate the proposed formulas. (J.G.B.)

1941 SEPARATION OF WEAKLY HYDRATED CATIONS IN AQUEOUS SOLUTIONS OF ALKALI METAL CHLORIDES. Oyari, P. (Inst. of Chemistry, Tallinn. Inst. of General and Inorganic Chemistry, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 4, 546-7(Apr 1971).

Translated from Zh. Fiz. Khim.; 45: No. 4, 976-7(Apr 1971).

The enthalpies of solution of rubidium chloride, potassium chloride, and cesium chloride in aqueous lithium chloride, sodium chloride, potassium chloride, and cesium chloride were measured. It was found that, for weakly hydrated salted-out cations, the relation between the separation and hydration of the salting-out cations passes through a minimum for all the pairs investigated. This is consistent with the theory put forward previously. (auth)

1942 ENRICHMENT OF EUROPIUM FROM DIDYMIUM CARBONATE BY SOLVENT EXTRACTION. Venkateswarlu, K. S.; Shanker, Ramendra; Kishore, Kamal (Bhabha Atomic Research Centre, Trombay, India). Indian J. Technol.; 9: No. 2, 58-60(Feb 1971).

A method is reported for the enrichment of europium from a mixed rare earth chloride solution by solvent extraction with his(2-ethylhexyl) phosphate in kerosene. Using a three-stage extraction followed by scrubbing and stripping, a 20-fold enrichment of Eu was achieved. (auth)

1943 REPROCESSING OF PLUTONIUM RECYCLE FUEL. Schneider, A.; Kendall, J. B.; Molen, G. F. (Allied-Gulf Nuclear Services, Barnwell, S. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 472-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1944 URANIUM ORE MILLING: PAST, PRESENT, AND FUTURE. Rosenbaum, Joe B.; George, D'Arcy R. (Bureau of Mines, Salt Lake City). Trans. Amer. Nucl. Soc.; 14: No. 2, 478(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1945 URANIUM ORE PROCESSING AT HUMBLE'S HIGHLAND OPERATIONS. Yung, K. K.; Abramo, J. A. (Humble Oil and Refining Co., Casper, Wyo.). Trans. Amer. Nucl. Soc.; 14: No. 2, 480(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1946 FROM URANIUM ORE TO METAL AND UF_6: DESCRIPTION AND RECENT DEVELOPMENTS OF FRENCH METHODS. Bodu, R. (CEA, Fontenay-Aux-Roses, France). Trans. Amer. Nucl. Soc.; 14: No. 2, 481(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1947 URANIUM CONVERSION AT ELDORADO NUCLEAR LTD. Tranmer, W. E. (Eldorado Nuclear Ltd., Port Hope, Ont.). Trans. Amer. Nucl. Soc.; 14: No. 2, 481-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1948 ADVANTAGES OF THE FLUORIDE VOLATILITY PROCESS IN URANIUM HEXAFLUORIDE CONVERSION. Bishop, J. C. (Allied Chemical Corp., Morristown, N. J.). Trans. Amer. Nucl. Soc.; 14: No. 2, 482(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1949 NITRIC ACID DISSOLUTION OF THORIA WAFER FUEL ELEMENTS. Schulz, Wallace W.; Pease, Richard A (Atlantic Richfield Hanford Co., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 487-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1950 SEPARATION OF DAUGHTERS OF ^{232}U FROM ^{233}U BY ION EXCHANGE. Rainey, Robert H.; Nicol, Ralph G. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 488-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1951 CORRELATION OF DISTRIBUTION EQUILIBRIA IN PUREX SYSTEMS. Goldberg, Stephen M. (Oak Ridge National Lab., Tenn.); Benedict, Manson; Levi, Hans W. Trans. Amer. Nucl. Soc.; 14: No. 2, 489-91(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1952 IN-BED COMBUSTION CALCINATION OF RADIOACTIVE WASTES. Lohse, G. E.; Thompson, T. K.; Wheeler, B. R. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc.; 14: No. 2, 495-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1953 GAS STRIPPING OF XENON FROM SODIUM FOR FUEL-FAILURE CHARACTERIZATION. Chellew, N.; Kessie, R.; Miller, W. E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 626(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1954 ENGINEERING FOR CRITICALITY CONTROL IN THE RECOVERY OF SPENT FUEL. Nichols, J. P. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 681-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1955 SEPARATION OF URANIUM(IV) AND (VI) BY THE METHOD OF PARTITION COLUMN CHROMATOGRAPHY. Luginin, V. A.; Tserkovnitskaya, I. A. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 873-4(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 898-9(Nov-Dec 1970).

A scheme of separation of uranium(IV) and (VI) by partition column chromatography, using bis(2-ethylhexyl)phosphate (D2EHPA) as the extraction reagent, is proposed. The method was tested on the analysis of a number of uranium containing samples. (auth)

1956 EXTRACTION OF NIOBIUM AND TANTALUM AND DETERMINATION OF PROTACTINIUM USING 1-PHENYL-3-METHYL-4-BENZOYL-5-PYRAZOLONE. Myasoedov, B. F.; Molochnikova, N. P.; Palei, P. N. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 798-803(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 829-35(Nov-Dec 1970).

The extraction of niobium and tantalum in the form of internal complex compounds with 1-phenyl-3-methyl-4-benzoyl-5-pyrazolone (PMBP) from solutions of hydrochloric, nitric, and sulfuric acids was investigated. The extraction of ^{59}Fe, ^{95}Zr, ^{95}Nb, ^{154}Eu, ^{182}Ta, ^{210}Po, ^{230}Th, and ^{233}U was studied under the optimum conditions for the isolation of protactinium. It was established that most of the elements investigated are not extracted under these conditions. For additional separation of protactinium from niobium and zirconium, the conditions of selective reextraction of protactinium were investigated. A method was developed for the separation of protactinium from macroquantities of iron, niobium, tantalum, and other elements. After the extraction of protactinium for 5 min from 5 N H_2SO_4, or 5 N H_2SO_4 and 0.005 M HF in the presence of Nb and Ta with a 0.1 M solution of PMBP in benzene, it is reextracted with a 0.1 M solution of HF. For separation from zirconium the reextraction is performed with a solution of 5 N H_2SO_4 containing 12% H_2O_2. (auth)

1957 USE OF NICKEL FERROCYANIDE AS A COLLECTOR IN THE PURIFICATION OF RADIOACTIVE SOLUTIONS FROM ^{137}Cs AND ^{90}Sr BY THE METHOD OF ELECTROFLOTATION. Shvedov, V. P.; Yakushev, M. F. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 846-9(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 876-9(Nov-Dec 1970).

The method of electroflotation of nickel ferrocyanide for the purification of a solution from radioisotopes of cesium and strontium was studied. It was shown that the maximum extraction of ^{137}Cs and ^{90}Sr lies in the region of pH 5 to 6. The extraction of ^{137}Cs depends on the potassium ferrocyanide concentration in solution. The maximum CP from ^{137}Cs was observed at a potassium ferrocyanide concentration of 60 mg/liter (at a pH of the solution equal to 6). The method of electroflotation of nickel ferrocyanide is convenient for the deactivation of solutions, since at one pH value (5 to 6) a substantial effect of purification both from ^{137}Cs and ^{90}Sr and from a mixture of radioisotopes is achieved. (auth)

1958 USE OF ELECTROPHORESIS, ELECTROCOAGULATION, AND ELECTROFLOTATION FOR THE PURIFICATION OF RADIOACTIVE WATERS. Shvedov, V. P.; Yakushev, M. F. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 840-5(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 871-6(Nov-Dec 1970).

Processes of purification of sewage from ^{90}Sr and ^{137}Cs by electrocoagulation and electroflotation with titanium, carbon steel, and Kh18N10T stainless steel electrodes were investigated. It was established that the maximum summary extraction of ^{90}Sr is achieved in the region of pH > 10. The CP with titanium electrodes is equal to 50, with electrodes of carbon steel ~28, and with electrodes of stainless steel ~18. It was shown that ^{137}Cs practically is not extracted by electrocoagulation; the extraction of ^{90}Sr does not exceed 20% at pH 10. About 60% of the radiocesium and more than 90% radiostrontium are extracted by electroflotation; in both cases the maximum is reached at pH values close to 6. The effects of electrocoagulation and electroflotation depend on the current density. At a current density of 0.02 A/cm^2 and less, the effect of purification of hydrosols is minimal. At a current density of 0.2 A/cm^2 and more, the rate of liberation of gas bubbles should provide for complete extraction of colloids into the foam product, both those present in the initial solution, and those formed as the result of electrocoagulation. (auth)

1959 SOME PROBLEMS OF THE PURIFICATION OF RADIOACTIVE SEWAGE BY EVAPORATION. Strizhov, S. G. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 850-3(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 879-82(Nov-Dec 1970).

The use of a film system of operation of an evaporating apparatus of the VV type permits complete elimination of foam formation during evaporation and permits a substantial increase in the effectiveness of the purification of radioactive sewage. The use of pumping of compressed air into the separator of the evaporating apparatus permits a reduction of the salt carryover by approximately twofold. Purification of radioactive sewage of the compositions cited occurs more effectively in alkaline medium than in acid medium. Dome plate fractional distillation columns are convenient to use and give high effectiveness of purification of secondary vapor. (auth)

1960 EXTRACTION OF TRANSPLUTONIUM ELEMENTS BY ALKYLAMMONIUM SALTS. Mueller, Werner (European Inst. for Transuranium Elements, Karlsruhe, Ger.). Angew. Chem. Int. Ed. Engl.; 10: No. 8, 580-1(Aug 1971).

Alkyl-substituted ammonium salts were used for extraction of trivalent transplutonium elements from concentrated chloride or nitrate solutions. On extraction of trivalent transplutonium elements from weakly acid, highly concentrated chloride solutions by tridodecylammonium chloride, ion pairs $R_3NH^+MCl_4^-$ are formed, which may be associated with additional molecules of the extractant. The differing strengths of these complexes permit separation of the element pairs Cf–Es and Am–Cm as well as their separation from the trivalent lanthanides. Am and Cm can be separated from each other by extraction from lithium nitrate solution by quaternary alkylammonium nitrates. Extraction chromatography by tridecylmethylammonium nitrate on kieselguhr as carrier, which was previously used for purification of Am and Cm in milligram amounts, was extended successfully to the separation and purification of ^{241}Am, ^{243}Am, and ^{244}Cm in multigram quantities. (TSS)

1961 ISOLATION OF NEPTUNIUM(IV) WITH HYDRAZINE. Chaikhorskii, A. A. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 767-8(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 794-5(Sep-Oct 1970).

A method of isolation of neptunium(IV) with the aid of hydrazine is proposed for the production of pure salts and the regeneration of spent solutions of neptunium under laboratory conditions. The principle of the method consists of the fact that neptunium is very rapidly reduced to the tetravalent form in concentrated nitric acid (12 M and above) in the presence of hydrazine, and it precipitates in the form of an insoluble double salt hydrazine hexanitratoneptunate with hydrazine nitrate $(N_2H_4)_2[Np(NO_3)_6] \cdot nN_2H_5NO_3$. (D.H.M.)

1962 EXTRACTION-CHROMATOGRAPHIC METHOD OF ISOLATING POLONIUM FROM A PROTON-IRRADIATED TARGET OF BISMUTH OXIDE. Raichev, Kh.; Khalkin, V. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 745-7(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 778-9(Sep-Oct 1970).

Model experiments on the adsorption of polonium on a TBP–Teflon column from 6 M HCl confirmed the hypothesis that the method of extraction chromatography permits an easy and rapid separation of polonium from macroquantities of bismuth, the most frequently used target element. It was found that polonium was quantitatively eluted from TBP by dilute HF. The experimental results obtained permitted the development of a simple rapid method of preparation of intense radiation sources for precision magnetic spectrography. (D.H.M.)

1963 SEPARATION OF TRANSPLUTONIUM AND RARE EARTH ELEMENTS ON AN ANION-EXCHANGE RESIN WITH CONCENTRATED SOLUTIONS OF LiCl IN THE PRESENCE OF ALCOHOLS. Guseva, L. I.; Tikhomirova, G. S. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 738-40(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 771-4(Sep-Oct 1970).

The distribution coefficients of Am and Eu in aqueous alcohol solutions of LiCl were determined as a function of the LiCl concentration (0 to 13.8 N) and the alcohol content in solution (0 to 60%). The possibility of using a solution of 8 N LiCl with 40% C_2H_5OH for the group separation of the transplutonium and rare elements on an anion-exchange resin at room temperature was demonstrated. The coefficient of separation of the pair $\alpha = D_{Am}/D_{Eu}$ is equal to 51 under these conditions. (auth)

1964 INFLUENCE OF THE NATURE OF THE DILUENT ON ANION- AND CATION-EXCHANGE EXTRACTION. Shmidt, V. S.; Smelov, V. S.; Shesterikov, V. N.; Drobysh, V. V. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 711-13(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 748-51(Sep-Oct 1970).

It was shown with 11 series of extraction systems including Am(III), Cr(III), U(Vi), V(IV), and Mn(II) extraction with DEHPA, Tc(VIII) extraction with amine sulfate, and Cl^- extraction with amine sulfate, amine bromide, and amine acetate, as examples, that in cases when extraction according to cation- or anion-exchange reactions leads to the formation of compounds differing significantly from the extraction reagent in polarity of the molecules, linear dependences of the logarithms of the extraction constants or logarithms of the distribution coefficients on the parameters BP*, characterizing the ability of the diluent for nonspecific solvation of the polar molecules of the extraction reagent and the compound to be extracted, are satisfactorily observed. In this case increasing the parameter BP* of the diluent leads to a shift of the equilibrium of the reaction of ion-exchange extraction in the direction of formation of the more polar compound. For the systems considered, the selectivity of the anion-exchange extraction increases with increasing BP* of the diluent, while the selectivity of cation-exchange extraction increases with decreasing BP* of the diluent. (auth)

1965 CONTINUOUS CHROMATOGRAPHIC SEPARATION OF A MULTICOMPONENT MIXTURE OF SUBSTANCES IN LIQUID–LIQUID PARTITION CHROMATOGRAPHY. III. BLURRING OF THE ZONES OF THE SUBSTANCES TO BE SEPARATED. Moskvin, L. N.; Tsaritsyna, L. G. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 699-704(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 737-42(Sep-Oct 1970).

A method was proposed for calculating the widths of the effluent curves in two-dimensional continuous chromatography with a flat ring of sorbent. The influence of the rate of water flow and the rate of rotation of the sorbent and the distribution coefficient on the shape and width of the effluent curves was investigated. A continuous separation of a mixture of Mo, W, and Re was conducted. (auth)

1966 CONTINUOUS CHROMATOGRAPHIC SEPARATION OF A MULTICOMPONENT MIXTURE OF SUBSTANCES IN LIQUID–LIQUID PARTITION CHROMATOGRAPHY. II. OPERATION OF THE DEVICE AND POSITION OF THE MAXIMA OF THE EFFLUENT CURVES. Moskvin, L. N.; Tsaritsyna, L. G. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 693-8(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 730-6(Sep-Oct 1970).

A design of an apparatus was proposed for continuous two-dimensional chromatography of a multicomponent mixture of substances with a flat ring of sorbent. The calculation formulas for describing the trajectory and angle of deviation of the components as a function of K_d, the rate of flow, and the rate of rotation of the ring of sorbent were experimentally verified; good correspondence of the calculated and observed values of the angles of deviation of the substances to be chromatographed from the direction of application of the initial mixture was demonstrated. Continuous chromatographic separation of Mo and Tc was conducted. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 2000, 2038, 2201, 2315, and 2584.

1967 (DEMO–71/10) USE OF RADIOISOTOPES IN TRACING KARST GROUNDWATER IN GREECE. I. FURTHER INVESTIGATION ON THE POSSIBLE INTERCONNECTION BETWEEN PARTHENI SINKHOLE AND VARIOUS SPRINGS OF THE NEAR AREA. Leontiadis, J.; Dimitroulas, Ch. (Democritus Nuclear Research Center, Athens (Greece)). Apr 1971. 13p. Dep. NTIS (U. S. Sales Only).

Iodine-131 in the form of NaI was used as a tracer to investigate the possible interconnection between the Partheni sinkhole on the high plateau of Tripolis and a number of springs of the area near Binikovi, Xovrios, Andritsa, Platanos Kastrou, Agia Paraskevi, Kiveri, and Andritsa spring. Quantitative calculations showed that all of the injected tracer, within the statistical error, emerged from Binikovi spring. The results are in agreement with the first conclusions of a parallel investigation of the same area using the environmental analysis method. (auth)

1968 (DEMO–71/13) ADSORPTION OF Cr-EDTA ON CARBON ACTIVE COLUMNS. Leontiadis, J.; Dimitroulas, C. (Democritus Nuclear Research Center, Athens (Greece)). Jun 1971. 23p. Dep. NTIS (U. S. Sales Only).

In order to increase the sensitivity of the determination of ^{51}CrEDTA, used as tracer in hydrological investigations, the enrichment of the tracer during sampling by the use of carbon-active columns was tested. The effects of various factors (sampling time, amount of active carbon, flow rate, concentration of the tracer etc.) on the adsorption of CrEDTA on the carbon were tested in the laboratory. The resulting technique may be considered as very attractive, as far as the minimum detectable concentration (0.001 μCi/m^3) and the possibility for quantitative calculations are concerned. (auth)

1969 (DEMO–71/14) USE OF RADIOISOTOPES IN TRACING KARST GROUNDWATER IN GREECE. II. INVESTIGATION ON THE POSSIBLE INTERCONNECTION BETWEEN SKOTINI SINKHOLE AND SPRINGS OF ARGOS AREA. Dimitroulas, C.; Leontiadis, J. (Democritus Nuclear Research Center, Athens (Greece)). Jun 1971. 20p. Dep. NTIS (U. S. Sales Only).

Radioactive ^{51}Cr-EDTA and NH_4Br as activable tracers were used for the investigation of the possible interconnection between Skotini sinkhole on the high plateau of Stymfalia and a number of springs in the Argos area, namely, Douka–Vrissi, Kefalari Argos, Kroi, and Lerni. Underwater scintillation counters, enrichment by carbon active columns, and neutron activation analysis were used for the determination of the tracers. Quantitative calculations showed that an amount of 1.92% of the water flowing into the Skotini sinkhole feeds the above mentioned springs through direct channels during the high flow period. (auth)

1970 (HEDL-TME–71-101) DISCUSSION OF SAND DIKES IN THE FFTF EXCAVATION. (Bechtel Corp., San Francisco, Calif.). 7 Jun 1971. Contract AT(45-1)-2170. 12p. Dep. NTIS.

For Hanford Engineering Development Lab., Richland, Wash.

The sedimentary structure and structural features observed in the FFTF containment bowl excavation are discussed with special emphasis on the dike-like features present. The term dike is used to designate, at this site, those structural features of clastic sedimentary material that transect the flat-lying glaciofluvial sands. These dike features have been described and are apparently common to the Touchet formation, and its coarser-grained facies, as exposed at the site. (J.R.D.)

1971 (LIB/Trans–298) CONTRIBUTION TO THE SELECTION OF RADIOACTIVE TRACERS FOR HYDROLOGY. Lallemand, A.; Grison, G. Translated for Australian Atomic Energy Commission Research Establishment, Lucas Heights from Symposium on the Use of Isotopes in Hydrology, Vienna, 9–13 March 1970. 12p. (CONF-700328–3; SM–129/52). Dep. NTIS (U. S. Sales Only).

The results of a systematic study of the behavior of a number of anionic and cationic tracers in illite, vermiculite, layered illite-vermiculite, montmorillorite, attapulgite and kaolinite are tabulated. Particle size did not have significant influence on the percentage of tracer recovered. The tracers ^{137}Cs, ^{32}P and ^{45}Ca were of little interest due to low recovery levels. The tracers ^{35}S, ^{3}H and ^{82}Br gave the best yields in all forms of soil and water. A second order group comprised ^{131}I for clayey rocks, ^{51}Cr for clayey rocks, dolomitic and siliceous sands, and ^{24}Na for sands and clays. A third order group consisted of ^{110}Ag for clayey rocks, ^{59}Fe for clayey rocks and siliceous sands and ^{14}C for chalky sands. (Australia)

1972 OBSIDIAN SOURCE IDENTIFICATION BY FISSION TRACK ANALYSIS. Durrani, S. A. (Univ. of Birmingham, Eng.); Khan, H. A.; Taj, M.; Renfrew, Colin. Nature (London); 233: No. 5317, 242-5(24 Sep 1971).

Fission track analysis was used to determine the age and uranium content of obsidians (volcanic glasses) from sources in southeast Europe and Anatolia, and from archaeological deposits in mesolithic levels at the Franchthi Cave in southern Greece. It was confirmed that the Franchthi obsidian came from the Aegean island of Melos. This is the earliest positive indication available for maritime travel, and carries the history of seafaring back a thousand years. (auth)

1973 ANOMALOUSLY HIGH ^{234}U/^{238}U RATIO IN A NATURAL SAMPLE. Sakanoue, M. (Kanazawa Univ., Japan); Komura, K. Nature (London) Phys. Sci.: 233: No. 39, 80–1(27 Sep 1971).

Following the discovery of the radioactive disequilibrium of the ^{234}U/^{238}U ratio in natural U, the ^{234}U/^{238}U anomaly has been shown to occur commonly in nature. This ratio is available for dating quaternary samples back to about one million years, because of the relatively long half life of ^{234}U (2.48×10^5 yr). The dating aspects and the geochemistry of the U and Ac series disequilibrium were studied, and some data are given for a maghemite sample collected in northeast Japan. The chemical and radiometric procedures are described in detail; an abnormally high ^{234}U/^{238}U ratio of about 15 was found. An abnormality was also found in the ^{230}Th activity, which was about nine times larger than the equilibrium value with the parent ^{234}U. The history of the sample is discussed and mechanisms are suggested for the ^{234}U enrichment. (UK)

1974 NOTE ON THE ISOTOPIC COMPOSITION OF ARGON IN QUARTZ VEINS. Harper, C. T.; Schamel, S. (Florida State Univ., Tallahassee). Earth Planet. Sci. Lett.; 12: No. 1, 129–33 (Sep 1971).

Vein quartz from the Monte Antola Nappe (Italy) contains excess ^{40}Ar in amounts ranging from 9.73×10^{-7} s.cm^3/g to 38.89×10^{-7} s.cm^3/g, correlating with structural depth within the nappe. (auth)

1975 USE OF NATURAL RADIOELEMENTS FOR SEDIMENT MEASUREMENT. Martin, J.-M. (Univ., Paris). Houille Blanche; 25: No. 8, 757-64(1970). (In French). (CONF-691135–2).

From Conference on the applications of radioelements in sedimentology; Paris, France (18 Nov 1969).

Instead of labeling sediments with artificial tracers, use can be made of natural radionuclides present in the sediment, or of artificial radionuclides originating from fallout or atomic power plant discharge. These various sources of radioactivity are briefly discussed and a few measurements are given, which show the general outlines of the method and its limits. (France)

1976 EVOLUTION OF TRITIUM ACTIVITIES IN SUPERFICIAL WATERS FROM AUSTRIA TO THE AQUITAINE SHORE BETWEEN 1968 AND 1970. Leveque, P. C. (Bordeaux Univ., Talaence, France). Compt. Rend., Ser. D; 273: No. 1, 19–22 (5 Jul 1971). (In French).

The evolution of tritium activities from the stratosphere due to military tests performed before 1963 was studied principally in the rivers and lakes and, according to an East–West direction, from the Austro–Helvetic barrier to the Atlantic ocean. The decrease of these activities was studied as a function of the altitude and the distance from the ocean. (France)

1977 PHENOMENOLOGICAL RELATIONSHIP FOR PREDICTING THE SURFACE AREA OF THERMAL PLUMES IN LAKES. Asbury, J. G.; Frigo, A. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 461-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1978 ANATOMY OF A THERMAL PLUME AND ITS BIOLOGICAL IMPLICATIONS. Hoglund, B.; Nelson, D.; Spigarelli, S. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 462(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971).

1979 CONCENTRATING RADIONUCLIDES IN ENVIRONMENTAL WATER SAMPLES WITH A CENTRIFUGAL CONTAC-

TOR. Milham, R. C. (E. I. duPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 463-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1980 INVESTIGATION AND MEASUREMENT OF RADIUM IN RAMSAR MINERAL WATER. Khademi, B.; Mesghali, A. (Teheran Univ.). Health Phys.; 21: No. 3, 464-5(Sep 1971).

Radioactivity of mineral waters from springs near Ramsar in N. Iran was investigated, the radium content of the water being measured by ^{222}Rn emanation. The ^{226}Ra concentrations in various springs at different times are tabulated and it is shown that they are above normal in some springs and are different from one to another even when springs are close together. The range was 2 to 10,000 pCi/l and there was also a seasonal variation showing higher concentrations in the winter. (UK)

Meteorology

Refer also to abstracts 2038, 2201, 2389, and 2391.

1981 (ORO-3944-3) ATMOSPHERIC HT AND HTO 1970-71. Technical Report, May 15, 1970-August 14, 1971. Oestlund, H. Goete (Miami Univ., Fla. Rosenstiel School of Marine and Atmospheric Sciences). Oct 1971. Contract AT(40-1)-3944. 26p. Dep. NTIS.

During the contract period, 15 May 1970 to 14 August 1971, ground-level sampling has been performed in Miami and, beginning 1 November 1970, in Fairbanks, Alaska. The HT-content of the atmosphere does not exhibit seasonal variations like HTO. An injection of HT to the northern atmosphere seems to have taken place shortly before 1 December 1970. Sampling into the northern polar stratosphere exhibits a very strong positive gradient of HTO, indicating the source of HTO being above the lower stratosphere. The vertical gradient of HT is negative, which confirms that the source of molecular tritium (HT or T_2) is at ground level. (auth)

1982 ^{134}Cs IN RAINWATER FROM 1960 TO 1969. Cigna, A. A.; Clemente, G. F.; Giorcelli, F. G. (CNEN, Rome). Health Phys.; 21: No. 5, 667-72(Nov 1971).

^{134}Cs was measured in samples of rainwater collected monthly at the Casaccia Nuclear Center (Rome). Measurements were performed by a $\gamma-\gamma$ sum coincidence technique on pooled yearly samples after a chemical separation of Cs. The results of these measurements are reported and compared with similar results obtained by others. The analysis of the data available led to the hypothesis that a major amount of this nuclide could have been injected into the stratosphere by nuclear tests before 1961. The contribution of the 1961 and 1962 explosions was less than expected, taking into account the increase of ^{137}Cs. The first Chinese test during 1964 seems to have given a detectable contribution to ^{134}Cs concentration in rainwater. During the period 1961 to 1965 the average yearly deposition was 33 ± 7 $\mu Ci/km^2$, while after 1965 it decreased to an average value of 2.2 ± 1.0 $\mu Ci/km^2$. The average $^{134}Cs/^{137}Cs$ ratio was about 1 per mille during the period 1961 to 1969. On the basis of the data reported, the origin of ^{134}Cs world-wide contamination is attributed to nuclear test explosions: while in some cases a good experimental evidence of soil or bomb material activation exists, the available data are not sufficient to assess a ^{134}Cs production due to fission. (auth)

1983 INFLUENCE OF PLUME RISE ON THE DISPERSION OF EFFLUENTS IN AIR. Yeh, Cheng S. (Atomic Power Development Associates, Inc., Detroit). Trans. Amer. Nucl. Soc.; 14: No. 2, 462-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Mineralogy and Exploration

Refer also to abstracts 1998 and 2046.

1984 (NP-19069) URANIUM MARKET. (Aktiebolaget Atomenergi, Studsvik (Sweden)). 1971. 30p. (In Swedish). (AES-8). Dep. NTIS (U. S. Sales Only).

The demand for uranium for use in nuclear power stations is projected to 1985 for the western world. The resources of uranium in western countries and the prospecting efforts are described. Present and future prices of uranium oxides are surveyed. (Sweden)

1985 (TID-25814) STATISTICAL DATA OF THE URANIUM INDUSTRY. (Grand Junction Office (AEC), Colo.). 1 Jan 1971. 54p. Dep. NTIS.

A compilation of historical facts and figures and current status as of Jan. 1, 1971 of the US uranium industry is presented. Information is included on ore and concentrate purchases, uranium resources, distribution of deposits, drilling statistics, land acquisition for U mining and exploration, employment, domestic U_3O_8 sales and projected requirements, and processing mills. (L.C.L.)

1986 PRELIMINARY STUDY OF THE DISTRIBUTION OF URANIUM AND THORIUM IN THE GRANITIC ROCKS OF SINGHBHUM. Saha, A. K. (Presidency Coll., Calcutta); Sankaran, A. V.; Bhattacharyya, T. K. Proc. Indian Nat. Sci. Acad., Part A; 36: No. 6, 392-7(Nov 1970). (CONF-681088-11).

From Symposium on the geology and mineralogy of atomic mineral deposits and their development for use in the nuclear power program; New Delhi, India (14 Oct 1968).

Eighteen representative specimens of Singhbhum granite (including 12 from magmatic members and six from the Bahalda metasomatic series) and two specimens of soda-granite along the Copper Belt thrust zone were used for fluorimetric determination of uranium, neutron activation analysis of thorium, flame photometric determination of K and Na in 15 specimens, wet chemical analysis of major constituents in five specimens, and point-count modal analysis and optical determinations of the compositions of the constituent minerals, and computation therefrom of the major element chemical composition of the rocks. The available data indicate abnormal richness of uranium in all three suites of rocks (by a factor >2), abnormally low thorium content in all the rocks except in soda-granite, and abnormally low Th/U ratios, the averages being 1.29, 1.01, and 2.36 for the magmatic members, Bahalda metasomatic series and soda-granites, respectively. In the magmatic units of Singhbhum granite, thorium showed fairly consistent positive correlations with Larsen Index, K% and Si%, while uranium showed only poor correlations with the above parameters; also in such rocks, the Th/U ratio showed highly significant positive correlation with the ratio $[(Fe_2O_3)/(FeO + Fe_2O_3)]$; all specimens with Th/U < 1 had $[(Fe_2O_3)/(FeO + Fe_2O_3)] < 0.4$, whereas all those with Th/U > 1 had $[(Fe_2O_3)/(FeO + Fe_2O_3)] > 0.4$. It is suggested tentatively that in parts of the magma with low oxygen pressure, the crystallizing rocks incorporated abnormally small amounts of thorium, leading to low Th/U ratios. In parts of the magma with higher oxygen pressure, uranium was partly leached out with the vapor phase or hydrothermal solutions and redistributed within the entire granite body, leading to its rather erratic distribution. In the Bahalda series of rocks which represents all stages of metasomatic granitization of hornblende schist to hornblende granodiorite, it appears that the uranium and thorium brought in by the granitizing fluids were preferentially incorporated in sphene, allanite, and other accessory minerals leading to the erratic distribution of both these elements. (auth)

1987 THORIUM, URANIUM, AND POTASSIUM DISTRIBUTION IN VOLCANIC ROCKS OF THE EAST-AFRICAN RIFT ZONE. Polyakov, A. I.; Sobornov, O. P. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya; No. 9, 1099-1109(Sep 1971). (In Russian).

Potassium, uranium, and thorium distributions in neogenic-quaternary volcanic rocks of the East-African rift zone (Kenya, Tanzania, Uganda) were studied. Special attention was given to the increased content of radioactive elements and in particular of uranium in the rocks studied in comparison with analogous rocks from other regions. Positive correlation bonds between thorium and uranium and in basalts between potassium, thorium, and uranium were observed. The contents of radioactive elements in lavas and intrusive rocks of analogous composition were similar. (auth)

1988 NEW EVIDENCE OF URANIUM AND OTHER MINERALIZATION IN SCOTLAND. Gallagher, M. J.; Michie, U. McL.; Smith, R. T.; Haynes, L. (Inst. of Geological Sciences, London). Trans. Inst. Mining Met.; 80: B150-73(Aug 1971).

New evidence of uranium, lead, zinc, copper, molybdenum, thorium, and fluorine mineralization is described from Caledonian granitic rocks and Old Red Sandstone sediments in northern Scotland. Uranium concentrations in Old Red Sandstone arkose overlying the Helmsdale granitic mass in the south of Caithness are tentatively regarded as tabular bodies modified by later faulting. The Helmsdale pluton is itself enriched in uranium occurring as disseminations in deeply weathered granite and along small structures, thus constituting a possible source of the uranium in the overlying arkose. Hydrocarbon, fluorite, pyrite and anomalous amounts of Cu, Pb, Mo, As and W are present in the arkose; galena and fluorite, accompanied by minor Zn, Mo and As, occur in uraniferous structures in the granite. In the Middle Old Red Sandstone of Caithness and Orkney, uranium is commonly present

in the range 100 to 1000 ppM U in thin phosphatic and dolomitic horizons and in fringing dolomitic conglomerates; certain horizons also carry galena and others are enriched in Mo, Zn and Cu. In southwest Scotland minor uranium veins have been discovered in the hornfels aureole of the Criffel granodiorite mass. Uranium vein deposits are spatially associated with this Caledonian pluton, despite the Triassic–Jurassic age of uraninite reported from the area. The presence of fluorite and molybdenum in the Grudie granite, Sutherland, and in a tin-bearing member of the Carn Chuinneag complex, Ross-shire, as well as in cross-cutting veins near the margins of the granite masses, also tends to suggest a genetic as well as a spatial relationship between Caledonian granitic rocks and later vein mineralization. (auth)

1989 REPORT OF THE NON-FERROUS ORES, METALS, AND SEMIPRODUCTS COMMITTEE. SIXTH PLAN 1971–1975. Ann. Mines; No. 5, 25-185(Jun 1971). (In French).

Ore production from the world mines and the long-term evolution of prices are reviewed and the particular aspects which concerned France during her Fifth Plan are considered. The most interesting features of the mining and metallurgical industries are reviewed. These features lead to the recommendations put forward by the committee which principally concern investments in France and abroad, and the encouragement of mineral prospecting and technical research. The report concludes by a study of the prospects for the Sixth Plan and their relation with developments accomplished during the Fifth Plan. Information is included on the evolution of world prices, the French balance of payments for products falling within the scope of the committee, investments envisaged during the Sixth Plan, labor problems, and mineral prospecting and technical research. Information is also included on Al, Co, Cu, Sn, ferrous alloys, Mg, precious metals, Ni, Pb, Ti, U, Zr, F, phosphates, potash, and salt. (France)

1990 PROSPECTS OF UTILIZING INDIAN PHOSPHORITES AS A SOURCE OF URANIUM. Dar, K. K. (Dept. of Atomic Energy, New Delhi). Proc. Indian Nat. Sci. Acad., Part A; 36: No. 6, 351-9(Nov 1970). (CONF-681088-7).

From Symposium on the geology and mineralogy of atomic mineral deposits and their development for use in the nuclear power program; New Delhi, India (14 Oct 1968).

Uranium has already been extracted on a commercial scale from phosphatic rocks in the USA as far back as 1952 by the Blockson Chemical Company in Joliet, Illinois, in 1955 by the International Minerals and Chemical Corporation, Bartow, Florida, and in 1957 by the Tennessee Corporation. On the basis of the estimate that the United States is losing 1,200 tons U_3O_8 annually from this source and is likely to lose as much as 2,000 tons U_3O_8 per year in the manufacture of high-grade triple superphosphates, wet process phosphoric acid, ammonium phosphate and other technical grade phosphorus chemicals, the prospects of extracting uranium from the phosphatic deposits in India during the manufacture of superphosphates, etc., are examined. The uranium content of some of the Indian phosphatic rocks compares well with that in deposits in the USA and other countries. The problem of uranium extraction is discussed with respect to the feasibility of the chemical precipitation and solvent extraction methods. Investigation of phosphatic deposits in India is now in its incipient stages. It is, however, roughly estimated that with an average grade of 0.015% U_3O_8 in phosphatic rocks, a 5-foot thick bed of phosphatic rock in a 1-mile square area would contain around 1,045 tons U_3O_8 of which 60 to 70% appears to be recoverable. These facts impart importance to phosphatic rocks as a large source of uranium. Certain lines of investigations necessary in this direction have also been suggested. (auth)

1991 EXPLORATION FOR URANIUM. King, John W. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 476(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1992 URANIUM EXPLORATION: A REVIEW. Shockey, P. N. (Teton Exploration Drilling Co., Ind., Casper, Wyo.). Trans. Amer. Nucl. Soc.; 14: No. 2, 476-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1993 CEA'S URANIUM PROSPECTING METHODS IN NIGER AND THEIR RESULTS. Bigotte, G. (CEA, Chatillon S/Ragneux, France). Trans. Amer. Nucl. Soc.; 14: No. 2, 477(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1994 OPEN-PIT URANIUM MINING. Graves, John A. (Anaconda Co., Grants, N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 477-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1995 ECONOMICS OF URANIUM ORE PROCESSING. Lankenau, A. W.; Light, R. H. (Hazen Research, Inc., Golden, Colo.). Trans. Amer. Nucl. Soc.; 14: No. 2, 478-80(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

1996 MARKETING URANIUM CONCENTRATES: SPECIFICATIONS, MEASUREMENTS, AND ACCOUNTABILITY. McGinley, Frank E. (Atomic Energy Commission, Grand Junction, Colo.). Trans. Amer. Nucl. Soc.; 14: No. 2, 480(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Oceanography

1997 (ORO–3622-12) U, Th, AND Pa ISOTOPES AS INDICATORS OF GEOLOGIC PROCESSES IN MARINE ENVIRONMENTS. Annual Progress Report, Part I. Rydell, Harold S. (Miami Univ., Fla. Rosenstiel School of Marine and Atmospheric Sciences). Aug 1971. Contract AT(40-1)-3622. 26p. Dep. NTIS.

From Aug 1970 to Aug 1971 several geochemical studies were initiated using Th and U isotopes as indicators of geological processes in the marine environment. Summaries are presented of the following investigations: the postdepositional mobility of some transition elements, P, U, and Th in deep-sea sediments; the final desiccation of the Afar Rift, Ethiopia; U content of Caribbean cores; mineralogy of Afar Rift, Ethiopia; Pa, Th, and U content in atmospheric dust; mineralogy and petrology of rock samples from fractured zones of the Equatorial Mid-Atlantic Ridge; and the Th and U isotope contents in marine ferromanganese deposits. (L.C.L.)

1998 URANIUM CONTENT IN BLACK ARGILLITES OF THE VOLGA STAGE OF THE WEST SIBERIAN PLATFORM AS CRITERION OF GEOCHEMICAL CONDITIONS OF SEDIMENTATION. Pluman, I. I. (Geological Board, Novosibirsk, USSR). Geokhimiya; No. 9, 1138-43(Sep 1971). (In Russian).

A similarity of geochemical peculiarities and in particular of uranium content has been established between recent deposits of seas with hydrosulfuric contamination (Black Sea, and others) and bituminiferous black argillites of the Upper Jurassic Volga stage of the West-Siberian platform. On this basis it was concluded that the geochemical sedimentation medium is identical with that of the Black Sea, i.e., it is hydrosulfuric in the above-bottom part of the sedimentation basin. (auth)

1999 ULTIMATE ENERGY NEEDS AND THE OCEAN ENVIRONMENT. Hammond, R. Philip (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 453(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Seismology

Refer also to abstracts 2021, 2022, and 2038.

2000 (UCRL–51110) EFFECTS OF WATER SATURATION ON UNDERGROUND NUCLEAR DETONATIONS. Butkovich, Theodore R. (California Univ., Livermore. Lawrence Radiation Lab.). 9 Sep 1971. Contract W-7405-eng-48. 17p. Dep. NTIS.

A calculational study with a one-dimensional computer code (SOC) was performed in an effort to understand how calculated ground motions from underground nuclear explosions are affected by the water content in various kinds of rock. The rock chosen for this study was an ashfall-ashflow tuff whose average density is 1.4 g/cm^3 and whose average dry porosity is 40%. The calculations were made with four different saturations: dry, 50% saturated, 90% saturated, and 100% saturated. The results show that at the same yield and depth of burial, vastly different ground motions can be produced in rocks having different water contents. Much more ground motion is produced in saturated rock than in dry rock. For example, a 0.5-kt detonation in 100% saturated tuff resulted in the same free-surface velocity and peak radial stress as a 10-kt detonation in dry tuff. (auth)

2001 COMMENTS ON THE PAPER "ANALYSIS OF GROUND MOTIONS AT SAN ONOFRE NUCLEAR GENERATING STATION APRIL 9, 1968." Boucher, Gary (Univ. of Nevada, Reno). Bull. Seismol. Soc. Amer.; 61: No. 3, 797-8(Jun 1971).

Ground motions from the April 8, 1968 Borrego Mountain earthquake were measured at the San Onofre nuclear power plant. The original analysis of the seismic data concluded that there were two seismic events. This analysis refutes that conclusion. (L.C.L.)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 1850, 2000, 2332, and 2355.

2002 (HN-200) EXCAVATION OF NUCLEAR CRATER SLOPES BY HYDRAULICKING METHODS FOR THE INTEROCEANIC CANAL. Perla, H. F. (Holmes and Narver, Inc., Los Angeles, Calif.). Jan 1969. 66p. Dep. NTIS.

The concept of lowering crater side slopes by excavating crater lip ejecta and other underlying material by use of hydraulicking methods was studied. A baseline concept was obtained from the Sandia study which considered the use of overexcavation techniques to obtain sufficient void in the crater to receive excavation material. Data is extended to provide for alternates to the baseline concept and these are presented. It is concluded that clearing, hydraulicking, and support costs for the Sandia overexcavation concept, taking advantage of more current topographic data and reduced side slope cotangents, are $106.5 million for Route 17A and $125.0 million for Route 17B of the Interoceanic Canal. (auth)

2003 (HN-201) FORCED HYDRAULIC TRANSPORT OF NUCLEAR EXCAVATED MATERIALS FOR THE INTEROCEANIC CANAL. (Supplement to HN-200). Perla, H. F. (Holmes and Narver, Inc., Los Angeles, Calif.). Jan 1969. 13p. Dep. NTIS.

An investigation was made of the cost of hydraulically relocating material to be removed from the sides of a nuclearly excavated canal. This material removal is required for increasing the slope stability of the craters which form the canal. The equipment and methods to be used for the forced transport of slurries are discussed. The amounts of material to be moved for the Route 17 interoceanic canal are estimated. It is concluded that forced hydraulic transport of the crater material is feasible, and that the cost for transporting clay shale over long distances (60,000 ft.) would be from 33 to 73¢/yd^3 and for short-haul (10,000 ft.) jungle disposal would be from 10 to 15¢/yd^3. (L.C.L.)

2004 (LMSC-D-177630(Vol.1)) STUDY OF NUCLEAR EXPLOSION SERVICES FIELDING SYSTEM. VOLUME I. ANALYSES AND RESULTS. Final Report, Phase II. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). 24 Jun 1971. Contract AT(26-1)-526. 316p. Dep. NTIS.

Under the Plowshare Program, nuclear explosives will be made available for industrial applications. As currently proposed, the Nuclear Explosion Services (NES) Fielding System is tasked with providing efficient, low-cost services to Plowshare industrial users. These services are: transportation of the nuclear explosive to the user's field emplacement site; supervision of emplacement; enabling and firing of the nuclear explosive; and technical review to ensure that user operations comply with Government-approved plans and procedures. This study comprises an analysis of NES functions and requirements, alternatives for accomplishment of the functions, and tradeoffs leading to the selection of a recommended NES System; description of the recommended NES System hardware, procedures, and costs; and recommendations for both NES system development tasks and areas for potential cost savings. The recommended system provides an NES organization based at Amarillo, Texas, and Las Vegas, Nevada. The Amarillo facility performs the explosive-transportation and field-security services. The Las Vegas facility provides program management, project management, emplacement supervision, enabling and detonation services, and technical review services. It also provides operational control for the Amarillo facility. Within the continental United States, explosives will be shipped by road convoys consisting of one or more explosive transporters, a fire truck, and an escort vehicle. Overseas shipment will be by commercial aircraft and truck. The basic Field Operations Group consists of one Project Manager, three Team Leaders, one Administrative Assistant, six Emplacement/Detonation Technicians, and six Security Personnel (17 total) for 24-hour operations. Additional technicians and security personnel augment this basic team for multiple-event projects, as necessary. (auth)

2005 NUCLEAR PROLIFERATION. Wentz, Walter B. Washington, D. C.; Public Affairs Press (1968). 224p.

An overall integrated view of the political and military implications of the proliferation of nuclear arms is presented. Information and discussions are included on nuclear options, consequences of nuclear acquisition, and alternatives of U. S. policy. (J.R.D.)

2006 ABSORPTION AND THE COMPLEXITY OF P SIGNALS. Douglas, A.; Marshall, P. D.; Corbishley, D. J. (United Kingdom Atomic Energy Authority, Blacknest, Eng.). Nature (London) Phys. Sci.; 233: No. 38, 50-1(20 Sep 1971).

It is stated that although most P signals from underground explosions are simple, some complex signals have been recorded, containing arrivals having amplitudes similar to or greater than the direct P but arriving several tens of seconds later than the first arrival. It is suggested that for such signals the direct P signal travelled by a path having lower average Q than the path followed by later arrivals, and was alternated relative to the later arrivals, the record then appearing complex. If this explanation is correct, the code of complex signals should contain a higher proportion of high frequency energy than the direct P, the high frequencies being attenuated more than the low frequencies in low Q paths. In cases in which both simple and complex signals from an explosion are recorded, the complex signals should have magnitudes greater than the simple signals because of the greater attenuation of P in the complex record. Evidence is presented to support this explanation of complexity, from seismogram data from an underground explosion in the USSR and recorded at Eskdolemuir in Scotland and Gauribidanur in India. The former signal was simple, whilst the latter was similar for the first few seconds, but complex overall. The magnitude of the explosion in the latter was lower than that indicated in the format. Other examples of complex explosion signals were also discussed, and the complexity of earthquake signals is briefly mentioned. (UK)

2007 PLOWSHARE: THE PEACEFUL USES OF NUCLEAR EXPLOSIVES. Whan, Glenn A. (Univ. of New Mexico, Albuquerque). Trans. Amer. Nucl. Soc.; 14: No. 2, 451-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2008 FACTORS THAT INFLUENCE THE SELECTION OF ^{238}Pu AND ^{244}Cm FOR SPACE POWER APPLICATIONS. Powers, James A. (Atomic Energy Commission, Washington, D. C.); Lamb, Eugene; Vallee, Richard E. Trans. Amer. Nucl. Soc.; 14: No. 2, 540-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2009 APPLICATION OF RTGs AND LARGE SOLAR ARRAYS TO BALLISTIC AND LOW-THRUST PROPELLED SPACECRAFT. Truscello, V. C.; Costogue, E. N. (California Inst. of Tech., Pasadena). Trans. Amer. Nucl. Soc.; 14: No. 2, 541-2 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2010 RADIATION TRANSPORT ANALYSIS OF A 2200-W(th) HELIPAK HEAT SOURCE. Koprowski, E. F. (ART Research Inc., Los Angeles); Jordan, T. M.; Noon, E. L. Trans. Amer. Nucl. Soc.; 14: No. 2, 545-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2011 RIO BLANCO DEMONSTRATION PROGRAM. Bray, Bruce G.; Luetkehans, Gerald R. (CER Geonuclear Corp., Las Vegas, Nev.). Trans. Amer. Nucl. Soc.; 14: No. 2, 687(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2012 PROJECT RULISON: SUMMARY OF RESULTS AND ANALYSES. Reynolds, Miles Jr. (Austral Oil Co., Houston, Tex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 687(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2013 PROJECT WAGON WHEEL: NUCLEAR EXPLOSIVE STIMULATION OF A NATURAL GAS WELL. Rogers, Leo A. (El Paso Natural Gas Co., Tex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 687-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2014 PREDICTION OF UNDERGROUND NUCLEAR EXPLOSION EFFECTS IN WAGON WHEEL SANDSTONE. Terhune, Robert W. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc.; 14: No. 2, 688(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2015 NATURAL GAS STORAGE. Randolph, Philip L. (El Paso Natural Gas Co., Tex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 688-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2016 STATUS OF PLOWSHARE GEOTHERMAL POWER. Stewart, D. H. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 689(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2017 PROJECT RULISON GAS FLOW ANALYSIS. Montan, D. N. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc.; 14: No. 2, 690(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2018 CHIMNEY GAS RADIOCHEMISTRY IN NUCLEAR GAS STIMULATION APPLICATIONS. Smith, C. F. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc.; 14: No. 2, 690-1(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2019 THERMAL EFFECTS OF UNDERGROUND NUCLEAR EXPLOSIONS. Taylor, R. W. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc.; 14: No. 2, 691(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2020 STATISTICAL ANALYSIS OF RULISON LOW-RISE BUILDING DAMAGE. Farhoomand, Iraj; Scholl, Roger E. (John A. Blume and Associates, San Francisco). Trans. Amer. Nucl. Soc.; 14: No. 2, 691-2(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2021 REVIEW OF THE GROUND-MOTION PREDICTION PROBLEM FOR PLOWSHARE UNDERGROUND ENGINEERING APPLICATIONS. Hays, Walter W. (Environmental Research Corp., Las Vegas, Nev.). Trans. Amer. Nucl. Soc.; 14: No. 2, 692-3(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2022 GROUND-MOTION PREDICTION METHOD FOR SIMULTANEOUSLY DETONATED MULTIPLE UNDERGROUND NUCLEAR EXPLOSIONS. Power, Dean V. (El Paso Natural Gas Co., Tex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 693(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2023 SOCIO-ECONOMIC ASPECTS OF A PLOWSHARE EXPERIMENT. Otway, Harry J. (Los Alamos Scientific Lab., N. Mex.); van der Harst, Leo; Higgins, Gary H. Trans. Amer. Nucl. Soc.; 14: No. 2, 694(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2024 REDUCTION OF TRITIUM FROM UNDERGROUND NUCLEAR EXPLOSIVES. Green, J. B. Jr.; Lessler, R. M. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc.; 14: No. 2, 694-5(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2025 CALCULATION OF STEAM EXTRACTION FROM NUCLEAR-EXPLOSION FRACTURED GEOTHERMAL AQUIFERS. Raghavan, Raj; Ramey, Henry J. Jr.; Kruger, Paul (Stanford Univ., Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 695(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2026 PRELIMINARY RESULTS ON FEASIBILITY OF LNG STORAGE IN NUCLEAR CHIMNEYS. Lasseter, Thomas J.; Witherspoon, Paul A. (Univ. of California, Berkeley). Trans. Amer. Nucl. Soc.; 14: No. 2, 695-6(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2027 EXPLOSIVE EXCAVATION RESEARCH: PROJECTS TUGBOAT AND TRINIDAD. LaFrenz, Robert L.; Day, Walter C. (Explosive Excavation Research Office, Livermore, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 696-7(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Facilities and Equipment

Refer also to abstracts 1979 and 2484.

2028 (CEA-CONF-1841) SAFETY TEST ON A HEAT PUMP DEVICE. Perrin, J.; Veyrat, J. F. 7 Jun 1971. 5p. (In French). (CONF-710628-2; PI(NT)-472-129/71). Dep. NTIS (U. S. Sales Only).
From Euratom conference on radiation devices; Cadarache, France (10 Jun 1971).
A safety study of the lower part of a thermopump irradiation device was made. A test was performed to analyze the damages undergone by the device and the reactor when the ruptures of both a sodium pipe and a cooling water pipe occur simultaneously. The accident had no consequential effect on the reactor operation and control. (France)

2029 (KFK-916) HIGH-PEAK CURRENT FACILITY WITH 57 kWs. Jacobi, S.; Schneider, R.; Will, F. (Kernforschungszentrum, Karlsruhe (West Germany). Labor fuer Elektronik und Messtechnik). Mar 1971. 31p. (In German). Dep. NTIS (U. S. Sales Only).
A high-peak current facility is described for use in a test facility for investigation of nuclear aerosols. It is designed to release electric power and energy to UO_2 samples in such a way that reactor excursions can be simulated. The study of nuclear aerosols so produced is intended to help in clarifying questions of reactor safety technology. The facility was designed specifically for experimental use. The essential design data, such as stored energy (max 56 kWsec) and discharging time (60 to 180 μsec/half-wave) were made variable. In view of the high maximum charging voltage (18 kV) of the energy storage capacitors and the resulting maximum discharging current of 0.3×10^6 A, considerable safety precautions were taken. (auth)

2030 (LB/G-2977) STUDY OF THE INFLUENCE OF A MAGNETIC FIELD ON THE BEHAVIOUR OF ELECTROSTATIC SEPARATORS. Simon, D. J.; Michelier, R. (European Organization for Nuclear Research, Geneva (Switzerland)). Translated by W. G. Stripp (Atomic Energy Research Establishment, Harwell, Eng.), from report MPS/Int.MU/SD 69-1. 30p. Dep. NTIS (U. S. Sales Only).
Limitations imposed on operation of electrostatic separators by the simultaneous presence of electric and magnetic fields were evaluated. It was found that such conditions cause a reduction of the limiting upper vacuum pressure for the system; this is considered a negligible factor in practice. Another result of the presence of these two fields is the appearance of a critical pressure at $\cong 10^{-4}$ torr above which any sparking which occurs in the separator is followed by a sustained discharge. Temporary removal of the magnetic field overcomes this unwanted reaction. (J.R.D.)

2031 (LB/G-2978) BABAR EJECTOR SYSTEM: AN EXPERIMENTAL FACILITY FOR HIGH-TEMPERATURE IRRADIATION OF FUEL IN A HELIUM ATMOSPHERE. Nogues, M.; Nervi, J. C.; Vidard, M. Translated by J. H. Dyer (Atomic Energy Research Establishment, Harwell, Eng.), from report MN/JCN/MVI/CV-70/113. 27p. Dep. NTIS (U. S. Sales Only).
During operation the reactor coolant was stabilized at 1000°C. The thermal energy was supplied entirely by an HTR-type fuel element. Information is included on characteristics of the irradiation basket, irradiation facility design, instrumentation, test procedures, temperature cycling, safety, ejector stability, calculation of fuel element power emission, and system operational experience. (J.R.D.)

2032 (TID-4100(Suppl.65)) ENGINEERING MATERIALS LIST. Supplement 65. Smith, Richard J.; Sachs, Francis L.; Clark, Willie E. (eds.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Sep 1971. 41p. DTIE Free.
Twenty-two packages of engineering drawings and specifications are presented. Packages of drawings are included on: storage container and packaging; K Series centrifuges; thermograph; ultrasonic wide band amplifiers; UO_2 to UF_6 conversion facility; 3.5-in. centrifugal contactor; dual phase lock-in detector; ICPP sample gallery, stations, and sampler tongs; 80-lens optical camera; Pu processing equipment; in-line H detector; high-resolution 15-in. mass spectrometer; large-volume 2-phototube neutron detector; spark chamber trigger amplifier; dilution flask and stirrers; HFT-1 dual bond tester; mass selector for mass spectrometer; avalanche transistor pulsers; gear checking machine; eddy current tester; equipment used in waste treatment; and high-fidelity electrode/preamplifier and amplifier for cardiography. (L.C.L.)

2033 IMPROVEMENTS TO U TUBE HEAT EXCHANGERS. (to Babcock-Atlantique). French Patent 2,049,022. 26 Mar 1971. Filed 30 May 1969. (In French).
A U-tube heat exchanger is described which is provided with a tubular plate whose input and exit zones are two concentric regions containing the same number of holes, the perforation network in each zone being determined from the intersection of two families of curves: a set of concentric circles, and a set of involutes developed from the smallest of these circles. (France)

2034 TRANSPORTING LARGE NSSS COMPONENTS. Eynon, W. J. (Babcock and Wilcox Co., Barberton, Ohio). Nucl. News; 14: No. 7, 35-9(Jul 1971).

It is noted that complexity and precision required in fabrication of large nuclear steam system components make shop fabrication with subsequent transport to the job site preferable. Methods and equipment used in transport are described. (J.R.D.)

2035 CATALYST SUPPORT AND A POSTCOMBUSTION REACTOR PROVIDED WITH SUCH SUPPORTS: METHOD OF MANUFACTURE. Bardet, Robert; Bottazzi, Henry; de Calmes, Alain; (and others) (to Commissariat a l'Energie Atomique). French Patent 2,039,527. 4 Jan 1971. Filed 2 Apr 1969. (In French).

The catalyst support consists of a metallic stainless steel frame, an intermediate Ni–Cr or nickel aluminide layer, and a surface zirconium oxide layer impregnated with a catalyst for the postcombustion of CO consisting of a thorium and uranyl nitrate solution doped with palladium. The postcombustion reactor and the fabrication process of the catalyst support are described. (France)

2036 CHATOU 1.5 MW(t) SODIUM LOOP: TEST FACILITY FOR FAST BREEDER REACTOR STEAM GENERATOR DEVELOPMENT. Brachet, A.; Lannou, L.; Quinet, J. L. (Electricite de France, Chatou). Bull. Dir. Etud. Rech., Ser. A; No. 1, 13-40 (1971). (In French).

The experimental 1.5 MW(t) sodium loop is described with a brief discussion on liquid metal technology experience acquired in the course of its construction and initial operation. (France)

2037 PERFORMANCE CHARACTERISTICS OF WATER HEAT PIPES OF ANNULAR WICK CONFIGURATION. Sockalingam, K. C.; Schrock, V. E. (Univ. of California, Berkeley). Trans. Amer. Nucl. Soc.; 14: No. 2, 436-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2038 OUTLINE OF EARLY ENVIRONMENTAL INFORMATION REQUIREMENTS FOR NUCLEAR PLANTS. Hartman, R. M. (Ebasco Services Inc., New York). Trans. Amer. Nucl. Soc.; 14: No. 2, 465-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2039 SOLAR AND CHEMICAL SPACE POWER SYSTEM POTENTIAL. Woodward, William H. (National Aeronautics and Space Administration, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 540(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2040 NUCLEAR ENGINEERING EDUCATION FROM A UTILITY VIEWPOINT. Long, Robert L.; Lee, Min L. (Consolidated Edison Co. of N. Y., Inc., New York). Trans. Amer. Nucl. Soc.; 14: No. 2, 760-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2041 HIGH-TEMPERATURE ELECTROMAGNETIC SODIUM PUMP. Adkins, H. E.; Olson , W. H. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: No. 2, 785-6 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2042 POST-TEST EXAMINATION OF THE LMEC ALCO/BLH STEAM GENERATOR. Slaughter, G. M.; DeVan, J. H.; Jones, R. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 787-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2043 FAILURES OF THREADED FITTINGS AT NUCLEAR FACILITIES. Scott, R. L.; Harley, P. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 788-90(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2044 GAS BOOSTER FOR USE WITH ARGON. Hirsch, P. R.; Marbach, R. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 871(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2045 REMOTELY ACTUATED TELEVISION SYSTEM. Kosky, R. P. (Combustion Engineering, Inc., Windsor, Conn.); Bagley, R. O. Trans. Amer. Nucl. Soc.; 14: No. 2, 885(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2046 POWER SUPPLY FOR AIR AND LAND VEHICLE-MOUNTED PROSPECTION EQUIPMENT FOR RADIOACTIVE MATERIALS. IEC Publication 253 1967. Geneva; Bureau Central de la Commission Electrotechnique Internationale (1967). 4p. (In French and English). Available from American National Standards Institute, New York.

Specifications are presented for the performance of storage batteries used as power supplies for air or land vehicle-mounted radioactive mineral prospecting equipment. (L.C.L.)

2047 GUIDE LINES FOR PIPE SUPPORT CONTRACTUAL RELATIONSHIPS. MSS SP-77 1971. Arlington, Va.; Manufacturers Standardization Society of the Valve and Fittings Industry (1971). 3p.

Guide lines published by the Manufacturers Standardization Society of the Valve and Fittings Industry are presented for the use and convenience of engineers, pipe fabricators, pipe erectors, pipe hanger designers, pipe hanger manufacturers, and for their customers. Information is included on the functions of the pipe hanger contractor, the purchaser's engineer, and the pipe fabricator and/or erector. (L.C.L.)

Heat Transfer and Fluid Flow

Refer also to abstracts 1977, 1978, 2037, 2044, 2078, 2136, 2647, 3828, 3836, and 3837.

2048 (CEA-N-1452) SOME EXAMPLES OF HEAT TRANSFER IN NONBOILING TWO-PHASE SYSTEMS. Delhaye, Jean-Marc (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Sep 1971. 47p. (In French). Dep. NTIS (U. S. Sales Only).

The most recent results concerning dropwise condensation, thermal energy storage, ablation, dispersed flows and direct contact exchangers are reviewed. Applications of such methods cover many subjects such as nuclear engineering, desalination, oceanography, space exploration, medicine and chemical engineering. (France)

2049 (IAE-1957) HYDRAULIC RESISTANCE OF FUEL ROD BUNDLES IN A BOILING WATER FLOW. Osmachkin, V. S.; Borisov, V. D. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 24p. (In Russian). INIS.

An analysis is made of the hydraulic resistance of multirod bundles cooled by boiling water moving along the axis of the bundle. The bundle of rods is regarded as a system of parallel channels (a network), between which thermal and dynamic interaction occur. A method of calculating the hydraulic resistance of the bundles is proposed, allowing for the presence of steam on the boiling surface, and the slip of vapor relative to the liquid. The similarity in geometry between bundles and tubes is taken into account in calculations of bundle characteristics. A method is proposed for reducing the bundle to a unidimensional channel. A test bench for studying thermo-hydraulic characteristics of a full-scale model of a boiling water reactor channel is described. Results are presented from the measurements of the pressure distribution in a boiling channel with a 19-tube bundle. (tr-auth)

2050 (RD/B/N-1845) GAS ENTRAINMENT MODELLING OF FLOWS IN WHICH A FREE SURFACE IS DISTURBED BY A JET OF LIQUID DIRECTED FROM BELOW. Higginbottom, D. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Dec 1970. 29p. Dep. NTIS.

Entrainment occurring when a free surface is disturbed by a jet of liquid reaching the surface from below was studied. A parameter is put forward to enable the results of water model tests on this type of flow to be used to predict entrainment behavior in similar sodium systems. (auth)

2051 DETERMINATION OF VAPOR CONTENT BY MEANS OF FLOW METERS. Vazinger, V. V. This paper was summarized in At. Energ. (USSR); 29: No. 3, 202(Sep 1970) as paper No. 421/5639. (In Russian).

Use of the technique involves measuring the mass flow in the medium being investigated. Results of studies indicate that Venturi tubes are best for measurements in channel-type boiling water reactors. These devices are versatile and are characterized by small irreversible losses. (J.R.D.)

2052 AXIAL HEAT TRANSFER IN PACKED BEDS. STAGNANT BEDS BETWEEN 20 AND 750°C. Beveridge, G. S. G. (Heriot-Watt Univ., Edinburgh); Haughey, D. P. Int. J. Heat Mass Transfer; 14: No. 8, 1093-1113(Aug 1971).

Many industrial applications of random packed beds of solid

particles involve axial high-temperature heat transfer. Mechanisms of conduction and radiation were evaluated independently of convective effects for such systems using a modified geometric model which allowed for flux line bending in the solid phase. This model was used to analyse experimental measurements for heat transfer in a stagnant bed of inert alumina-silicate balls over the temperature range 20 to 750°C. Comparisons with other theoretical models and experimental data are also made. (auth)

2053 LAMINAR FORCED CONVECTION IN ECCENTRIC ANNULI. Trombetta, Michael L. (Los Alamos Scientific Lab., N. Mex.). Int. J. Heat Mass Transfer; 14: No. 8, 1161-73(Aug 1971).

Forced convection to hydrodynamically and thermally fully developed laminar flow in eccentric annuli was studied. Solutions of the energy equation which satisfy certain fundamental boundary conditions were determined. These fundamental solutions could be superposed to satisfy a wide variety of boundary conditions. Exact solutions of the energy equation could not be found, so an approximate solution was determined. Nusselt numbers, wall temperature and heat fluxes, wall-fluid temperature differences, and mean fluid temperatures are presented for a wide range of eccentricities and radius ratios. It is believed that these results are accurate to within 1%. (auth)

2054 CALCULATION OF HEAT TRANSFER IN TURBULENT FLOW WITH ALLOWANCE FOR SECONDARY FLOW. Ibragimov, M. H.; Petrishchev, V. S.; Sabelev, G. I. (Atomic Energy Inst., Obninsk, USSR). Int. J. Heat Mass Transfer; 14: No. 8, 1013-31(Aug 1971).

A calculation method is proposed for the determination of the temperature field in a fluid in non-circular ducts. Results are given for the case of turbulent flow in a square duct. For comparison, results of measurements are presented of a temperature field in fluid flow under conditions close to those assumed in the calculations. (auth)

2055 TEPLO-MASSOPERENOS V ODNO- I DVUKHFAZNYKH SREDAKH. (Heat-Mass Transfer in Single- and Two-Phase Media). Alad'ev, I. T. (ed.). Moscow; Izdatel'stvo Nauka (1971). 164p.

This volume is a collection of 21 articles concerned with the processes of discharge from nozzles and jets of steam and gas–liquid mixtures and with convective, conductive, and radiative heat exchange in one- and two-phase streams. The work reported is chiefly original, theoretical and experimental investigations of a laboratory specializing in heat exchange. A few papers represent critical surveys of the contemporary aspects of the problems. One of the 21 articles was selected for separate abstracting because it deals with the specific subject of magnetohydrodynamics. (K.S.W.)

For an abstract of an individual paper see: 2850.

2056 TURBULENT LATERAL MASS TRANSPORT BETWEEN RODS IN BOILING SYSTEMS. Kondic, Nenad N. (Babcock and Wilcox, Lynchburg, Va.). Trans. Amer. Nucl. Soc.; 14: No. 2, 655-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2057 SAMPLING OF ENTRAINED PARTICLES DEPOSITION AND RE-ENTRAINMENT. Beal, S. K. (Westinghouse Electric Corp., Elk Grove, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 656(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2058 MODEL FOR FORCED-CONVECTION INTERCHANNEL MIXING INDUCED BY HELICAL SPACER WIRES. Ginsberg, T. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 656-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2059 MULTICHANNEL CALCULATIONS WITH OR WITHOUT HYDRAULIC COUPLING. Sha, W. T.; Marr, W. W.; Lo, R. K. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 657-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2060 PRESSURE DROP MODEL FOR WIRE-WRAPPED FUEL ASSEMBLIES. Novendstern, E. H. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 660-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2061 DISCRETE-TIME NEUTRON INTERROGATION OF LIQUID FLOW SYSTEMS. Hancox, W. T. (Westinghouse Canada Ltd., Hamilton, Ont.); Harms, A. A. Trans. Amer. Nucl. Soc.; 14: No. 2, 699-700(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2062 VISUAL STUDIES OF BUBBLE NUCLEATION AND GROWTH IN WATER BLOWDOWN. Hoeppner, G.; Schrock, V. E. (Univ. of California, Berkeley). Trans. Amer. Nucl. Soc.; 14: No. 2, 701(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2063 DRYOUT AND POST-DRYOUT BEHAVIOR OF A 28-ELEMENT FUEL BUNDLE. McPherson, G. D. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Matzner, B.; Castellana, Frank; Casterline, J. E.; Wikhammer, G. A. Trans. Amer. Nucl. Soc.; 14: No. 2, 701-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2064 PRESSURE DROP MEASUREMENTS IN A 36-ROD BUNDLE AT 70 atm. Grillo, P.; Mazzone, G. (CNEN, Rome). Trans. Amer. Nucl. Soc.; 14: No. 2, 702-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2065 TURBULENT LIQUID-METAL HEAT TRANSFER IN ANNULAR CHANNELS. Singer, Ralph M.; Henry, Robert E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 721(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2066 FORCED-CONVECTION SODIUM SUPERHEAT. Henry, Robert E.; Singer, Ralph M. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 723-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2067 INCIPIENT SUPERHEATS IN SODIUM WITHOUT THE PRESENCE OF INERT GAS. Holtz, R. E. (Argonne National Lab., Ill.); Fauske, H. K.; Eggen, D. T. Trans. Amer. Nucl. Soc.; 14: No. 2, 724-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2068 HEAT TRANSFER EXPERIMENTS THROUGH BEDS OF UO_2 PARTICLES IN BOILING SODIUM. Sowa, E.; Hesson, J.; Gebner, R.; Goldfuss, G. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 725-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2069 CALORIMETRY AS AN AID TO THERMAL ANALYSIS OF IRRADIATION CAPSULES. Fleischer, B.; Washburn, T. N.; Thoms, K. R. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 763(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2070 DYNAMICS OF TRANSITION BOILING. Peterson, W. C.; Zaalouk, M. G. (North Carolina State Univ., Raleigh). Trans. Amer. Nucl. Soc.; 14: No. 2, 776(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2071 PROMPT DETECTION OF BOILING THROUGH ACOUSTICS. Butler, Walter R.; Munno, Frank J. (Univ. of Maryland, College Park). Trans. Amer. Nucl. Soc.; 14: No. 2, 776-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Isotope Technology

Refer also to abstracts 1936, 1967, 1969, 1971, 2137, 2480, 2510, 2990, and 4007.

2072 (BNWL-1621) RADIOISOTOPE BIBLIOGRAPHY. Reports and Publications of General Electric Company, Hanford Atomic Products Operations (1960–1964), and Battelle-Northwest (1965–mid 1971). Jarrett, J. H. (comp.) (Battelle Pacific Northwest Labs., Richland, Wash.). Sep 1971. Contract AT(45-1)-1830. 114p. Dep. NTIS

A bibliography is presented in which all the reports and publica-

tions related to radioisotopes issued by the General Electric Company–Hanford Atomic Products Operations (1960 to 1964) and Battelle-Northwest (1965 to mid 1971) are listed. The entries are divided into broad subject areas, indexed by author, and indexed by radioisotope. The bibliography provides a useful and usable compilation of radioisotope-related information. (auth)

2073 (CEA-R-4186) APPROXIMATE SOLUTIONS TO THERMAL COUNTERCURRENT CENTRIFUGE PROBLEMS. Soubbaramayer (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jul 1971. 23p. (In French). Dep. NTIS (U. S. Sales Only).

Assuming that the thermal countercurrent in a gas centrifuge obeys a linearized theory, and that the temperature distributions on the centrifuge caps are symmetrical, a first approximation of the velocity field is obtained. Mathematical expressions for the the main separation parameters (the normalized and absolute countercurrent flowrates and the separation efficiency) are also obtained. The optimum temperature distribution on the caps is deduced from these parameters. Some numerical examples are given. (France)

2074 (LB/G-2984) TOWARD NEUTRON RADIOGRAPHY USING SMALL ACCELERATOR SOURCES. Vu Hong Lac; Berthod, J.; Breynat, G. Translated by E. V. J. Theumer and C. R. Brightmore (Atomic Energy Research Establishment, Harwell, Eng.), from pp 99-111 of Proceedings of the 6th International Conference on Nondestructive Testing, Hanover, 1–5 June 1970. 11p. (CONF-700613–5). Dep. NTIS (U. S. Sales Only).

An accelerator that provides 14 MeV neutrons was investigated as source for thermal neutron radiography. For each system of moderators used (light water or a combination of light water and heavy water) the position and the dimensions of the collimator were optimized. At the same time the thermal flux was increased by fission reactions inside blocks of natural uranium placed around the target of the accelerator. These results were applied to an accelerator that provides 2.10^{11} n/4π sec. A radiography study was conducted using detectors such as Gd, SZn + LiF scintillators and activation detectors Dy and In. For fast neutron radiography (14 MeV and 3 MeV), the study was concerned principally with improved scintillators. (auth)

2075 (MLM-1869) STABLE ISOTOPE SALES: MOUND LABORATORY CUSTOMER AND SHIPMENT SUMMARIES, FY-1971. Stringham, W. S. (comp.) (Mound Lab., Miamisburg, Ohio). 20 Oct 1971. Contract AT(33-1)-Gen-53. 23p. Dep. NTIS.

A listing is given of Mound Laboratory's sales of stable isotopes of noble gases and carbon for Fiscal Year 1971. Purchasers are listed alphabetically and are divided into domestic and foreign groups. A cross-reference index, by location, is included for domestic customers. Cross-referenced listings, by isotope purchased, are included for all customers. (auth)

2076 (ORNL-TM-3529) ISOTOPE PROGRAM (5000) PROGRESS REPORT FOR QUARTER ENDING JUNE 30, 1971. Gillette, J. H. (Oak Ridge National Lab., Tenn.). Aug 1971. Contract W-7405-eng-26. 12p. Dep. NTIS.

Research and development activities are reported on target fabrication, isotopic separations, ^{85}Kr recovery, chemical processing, and isotope preparation for marketing. (J.R.D.)

2077 NEW METHOD FOR RARE-EARTH ISOTOPE SEPARATION. Beyer, G. J.; Herrmann, E.; Piotrowski, A.; Raiko, J.; Tyrroff, H. (Joint Institute for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 96: No. 3, 437-9(1971).

A new method is described for electromagnetic isotope separation of radioactive rare-earth elements. The chemically pure fractions of rare-earth elements obtained by cation-exchange chromatography technique and deposited in the process of cathode precipitation on a tungsten foil were loaded into a pipetype-surface ionization ion source. The isotope separation time was approximately 3 min, the separation efficiency in the case of Nd isotopes amounted up to 80% and for Dy up to 66%. (auth)

2078 NEW PROCEDURE FOR HUMIDITY MEASUREMENTS OF WET STEAM BY MEANS OF RADIOACTIVE ISOTOPES. Csom, G.; Benedek, S. Waerme; 76: No. 5, 130-5(1970). (In German).

New possibilities for the determination of the humidity content of wet steam in steam turbines are discussed. The relationship between the flow rates (stagnant and flowing wet steam) of two-phase media and steam humidity is investigated. Theoretical problems of two measuring methods (measurement of the energy of ^{239}Pu α particles and compensation measurement of the effective range of ^{239}Pu α particles) are discussed. Both procedures are usable for steam at pressures from 0.03 to 1.5 atm with an error of about ±0.4 to ±1.1% humidity. (INIS)

2079 RADIOISOTOPE/ELECTROTHERMAL THRUSTER. Simms, Richard (to United States Atomic Energy Commission). U. S. Patent 3,583,161. 8 Jun 1971. Filed 1 Aug 1966.

Greater efficiency in a monopropellant rocket engine is achieved by use of an upstream radioisotope heater and a downstream electric heater or other electrothermal sources. (Official Gazette)

2080 PROCEEDINGS OF THE 24th POWER SOURCES SYMPOSIUM, HELD AT FORT MONMOUTH, NEW JERSEY, MAY 19–21, 1970. Red Bank, N. J.; PSC Publications Committee (1970). 228p. (CONF-700562).

Results of government, university, and industrial investigations of power sources are discussed and summarized. Information is presented in 60 papers on secondary batteries, fuze power sources, thermal energy conversion, requirements for power sources, primary batteries, power processing, U. S. Army electronics research, fuel cells, and U. S. Navy research and development. A separate abstract was prepared for each of the three papers that are in scope for NSA. (J.R.D.)

For abstracts of individual papers see: 2081, 2082, and 2458.

2081 STATUS REPORT ON SNAP 27. Pitrolo, A. A. pp 61-5 of Proceedings of the 24th Power Sources Symposium. Red Bank, N. J.; PSC Publications Committee (1970).

From twenty-fourth power sources symposium; Fort Monmouth, N. J. (19 May 1970). See CONF-700562.

A review of the development and performance of SNAP 27 is presented. It is noted that results of Apollo 12 mission and over 28,000 system test hours demonstrated the reliability of this power isotopic source. (J.R.D.)

2082 SESSION ON REQUIREMENTS FOR POWER SOURCES: NASA. Schulman, Fred (National Aeronautics and Space Administration, Washington, D. C.). pp 75-7 of Proceedings of the 24th Power Sources Symposium. Red Bank, N. J.; PSC Publications Committee (1970).

From twenty-fourth power sources symposium; Fort Monmouth, N. J. (19 May 1970). See CONF-700562.

Equipment and methods available to meet the power requirements of NASA are discussed. Sources include batteries, solar arrays, fuel cells, nuclear reactors, and radioisotope-powered systems. (J.R.D.)

2083 INCREASES IN THE PRICE OF ENRICHMENT IN THE USA: $26, $28.70, AND $32 PER UTS. Sugier, N. (CEA, Paris). Energ. Nucl. (Paris); 13: No. 3, 232(May 1971). (In French).

The reasons given by the USAEC justifying their decision to increase the price of uranium enrichment in September 1971 are analyzed. The cost involved by the USAEC in the enrichment process are studied and the $32 and $26 tariffs are discussed. The validity of hypotheses put forward by the USAEC in calculating the $32/UTS figure and the possible consequences of further modification (GAO report) are discussed. The decision taken by the USAEC is critically examined. (France)

2084 PLUTONIUM HEAT SOURCE. Kelly, Donald P.; Powers, James A.; Tucker, Philip A. (to United States Atomic Energy Commission). U. S. Patent 3,600,585. 17 Aug 1971. Filed 3 Feb 1967.

A radioisotopic heat source for a thermoelectric generator having a plutonium-238 alloy enclosed within a tantalum container and an arc melting method and apparatus to produce the alloy are described. (Official Gazette)

2085 SPACE HEAT SOURCE. Anderson, Charles G. (to United States Atomic Energy Commission). U. S. Patent 3.596,853. 3 Aug 1971. Filed 13 Aug 1969.

A space capsule is described that includes heat source devices individually recoverable in which each heat source device includes a combined pyramidal-type reentry body and heat reflector and a radioisotopic heat source disposed in a hollow or concave portion of the body. (Official Gazette)

2086 SNAP-19 NUCLEAR POWER SUPPLY EXPERIMENT ON NIMBUS III. Fihelly Arthur W. (Goddard Space Flight Center, Greenbelt, Md.); Baxter, Charles F. Trans. Amer. Nucl. Soc.; 14: No. 2, 438(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2087 ROLE OF SNAP-27 IN THE APOLLO PROGRAM. Davin, E. (National Aeronautics and Space Administration, Washington, D. C.); Carpenter, E. Trans. Amer. Nucl. Soc.; 14: No. 2, 438-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2088 RADIOISOTOPE POWER ON PIONEER F AND G. Wilbur, A. C. (Ames Research Center, Moffett Field, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 439(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2089 VIKING: MISSION TO MARS. Smith, Robert D.; Hughes, J. Kenrick; Cuddihy, William F. (Langley Research Center, Hampton, Va.). Trans. Amer. Nucl. Soc.; 14: No. 2, 439-40(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2090 TOPS/RTG TECHNOLOGY PROGRAM FOR MULTI-OUTER PLANET FLYBY MISSIONS. Ivanoff, Robert G.; Truscello, Vincent C. (California Inst. of Tech., Pasadena). Trans. Amer. Nucl. Soc.; 14: No. 2, 440(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2091 SURVEY OF SPACE MISSIONS POTENTIALLY REQUIRING RADIOISOTOPE HEATER UNITS. Goranson, R. B. (McDonnell Douglas Astronautics Co., Richland, Wash.); Shivers, R. W. Trans. Amer. Nucl. Soc.; 14: No. 2, 440-1(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2092 RADIOISOTOPE APPLICATIONS. Carroll, Edward E. Jr. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc.; 14: No. 2, 450-1(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2093 RADIOISOTOPE POWER SOURCES FOR UNDERWATER APPLICATIONS. Cope, Ronald P.; Fleming, Thomas P. (Naval Facilities Engineering Command, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 454-5(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2094 AIR IONIZATION USED FOR LIGHTNING PROTECTION. Invernizzi, C. G. Trans. Amer. Nucl. Soc.; 14: No. 2, 469-70(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2095 ECONOMICS OF EXISTING AND IMPROVED U. S. GASEOUS DIFFUSION PLANTS. LeGassie, Roger W. A. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 482-3(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2096 PREVISIONAL OPERATION OF NEW ENRICHMENT CAPACITIES. Pecqueur, M.; Coates, J. H.; Mezin, M. (CEA, Fontenay-Aux-Roses, France). Trans. Amer. Nucl. Soc.; 14: No. 2, 483(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2097 DEVELOPMENT AND USE OF LOW-ENERGY GAMMA, SECONDARY X-RAY, AND BETA SOURCES. Pressly, R. S. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 497-8(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2098 BNL COBALT RADIATION SOURCES. Wagner, J.; Oltmann, A. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 498-9(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2099 RADIOISOTOPE SOURCE SAFETY TESTING. Niemeyer, R. G. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 499-500(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2100 RADIOISOTOPE-POWERED CARDIAC PACEMAKER DEVELOPMENT PROGRAM. Hursen, T. F.; Maurer, G. W.; Kolenik, S. A. (NUMEC, Pittsburgh). Trans. Amer. Nucl. Soc.; 14: No. 2, 505-6(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2101 NUCLEAR BATTERY FOR THE CARDIAC PACEMAKER. Bustard, Thomas S. (Hittman Associates, Inc., Columbia, Md.). Trans. Amer. Nucl. Soc.; 14: No. 2, 506-7 (Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2102 COMPARISON OF VENTED AND UNVENTED ^{238}Pu HEAT SOURCES. Purdy, D. L.; Bodenschatz, C. A.; Garber, H. J. (NUMEC, Pittsburgh). Trans. Amer. Nucl. Soc.; 14: No. 2, 507(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2103 INDUSTRIAL STATUS OF ^{238}Pu SOURCES. Schimmel, R. L. (Monsanto Research Corp., Dayton, Ohio). Trans. Amer. Nucl. Soc.; 14: No. 2, 507(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2104 SAFETY ASPECTS OF FUEL CAPSULES FOR MEDICAL PURPOSES. Bodenschatz, C. A.; Blair, M. G.; Maurer, G. W.; Hursen, T. F. (NUMEC, Pittsburgh). Trans. Amer. Nucl. Soc.; 14: No. 2, 507-8(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2105 USAEC REGULATION OF NUCLEAR-POWERED CARDIAC PACEMAKERS: A STATUS REPORT. Cunningham, Richard E. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 510(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2106 INDUSTRIAL USE OF RADIOISOTOPES FOR IMPLANTABLE DEVICES. Matheson, Willard E. (McDonnell Douglas Astronautics Co., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 511-12(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2107 ^{244}Cm AND ^{252}Cf FOR NEUTRON RADIOGRAPHY. Barton, J. P. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 516(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2108 DEVELOPMENTS IN LOW-FLUX NEUTRON RADIOGRAPHY AT BATTELLE-NORTHWEST. Swinth, K. L. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 516-17(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2109 BOOSTING NEUTRON OUTPUT FROM A ^{252}Cf IRRADIATOR SAFELY AND ECONOMICALLY. Miller, L. G.; Watanabe, T.; Kunze, J. F. (Aerojet Nuclear Corp., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: No. 2, 517-18 (Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2110 PERFORMANCE EXPERIENCE WITH PROTOTYPE BETACEL NUCLEAR BATTERIES . Lewis, Milton; Seeman, S. E. (McDonnell Douglas Astronautics Co., Richland Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 525(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2111 ANALYTIC AND EXPERIMENTAL RADIATION SIMULATION OF A RADIOISOTOPE THERMOELECTRIC GENERATOR. Campbell, R. W. (California Inst. of Tech., Pasadena); Noon, E. L.; Koprowski, E. F. Trans. Amer. Nucl. Soc.; 14: No. 2, 546(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2112 NUCLEAR RADIATION ENVIRONMENT FROM SIMULATED RTGs WITHIN A TEST FACILITY. Noon, E. L. (California Inst. of Tech., Pasadena); Koprowski, E. F. Trans. Amer. Nucl. Soc.; 14: No. 2, 547(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2113 THULIUM OXIDE HEAT SOURCE AND METHOD FOR FORMING SAME. Allen, Charles H.; Leach, Charles E. (to United States Atomic Energy Commission). U. S. Patent 3,603,415. 7 Sep 1971. Filed 9 Aug 1968.
An internally-shielded radioisotopic heat block is described in which the preferred fuel, thulium oxide rods is separated from the coolant by a metal heat-exchange medium. The fuel elements may be removed from the heat block with only moderate shielding and reirradiated while still clad. (Official Gazette)

Materials Testing

Refer also to abstracts 2031, 2042, 2107–2109, 2519, 2579, 3515, 4088, and 4089.

2114 (ANL–7840) PROCEDURAL CHANGES IN THE QUALITY EVALUATION OF CP-5 REACTOR FUEL. Brandenburg, R. W.; Gehrke, R. C.; Dentamaro, V. (Argonne National Lab., Ill.). Sep 1971. Contract W-31-109-eng-38. 8p. Dep. NTIS.

The gamma assay of the CP-5 reactor fuel is a part of a quality verification program that includes radiographic as well as ultrasonic testing. The modification of the gamma-ray scintillation spectrometric technique is described. This modification improved the precision of the results, simplified the fuel handling, and increased the efficiency. Scanning time was reduced approximately 50% while the relative precision was increased approximately 7%. (auth)

2115 (HEDL-TME–71-132) MODULATION TRANSFER FUNCTION AND EFFECTIVE FOCAL SPOT AS RELATED TO NEUTRON RADIOGRAPHY. Bossi, R. H.; Cason, J. L.; Jackson, C. N. Jr. (Hanford Engineering Development Lab., Richland, Wash.). [1971]. Contract AT(45-1)-2170. 31p. Dep. NTIS.

The modulation transfer function (MTF) has been proposed for use in describing image quality capability in neutron radiography. The results of an initial experiment provide quantitative measure of the neutron source's beam resolution characteristics as related to image formation. The effective focal spot of a neutron source has also been defined in conjunction with the MTF analysis in order to establish a basis for comparing neutron sources, as well as characterizing unsharpness and radiographic sensitivity. The effective focal spot, similar to the x-ray focal spot in use, is not necessarily a collimator input diameter, but rather represents the effective ability of a collimator to provide a directed beam of neutrons, taking into account neutron scatter and penumbra effects. For this investigation, the neutron source was the Plutonium Recycle Critical Facility (PRCF). A comparison of the PRCF with other neutron sources for radiography may be made by use of the MTF. The effective focal spot was found to be about 3.1 inches. (auth)

2116 (ORNL–TM–3520) PHASE REPORT NO. 115-10 ON COMPARISONS OF TEST DATA WITH CODE METHODS FOR FATIGUE EVALUATION. Rodabaugh, E. C.; Moore, S. E. (Battelle Memorial Inst., Columbus, Ohio). Nov 1971. Contract W-7405-eng-26; Subcontract 2913. 78p. Dep. NTIS. For Oak Ridge National Lab., Tenn.

In an effort to evaluate proposed design rules for the fatigue analysis of piping system components available, experimental data are summarized and analyzed. Under specific considerations are ASME Code Case 1441 published in December 1969 and certain revisions which are being considered for adoption by ANSI B31.7—the nuclear power piping section of the American National Standards Institute Standard Code for Pressure Piping. Fatigue failure data obtained from the published literature are compared with design values calculated according to the rules of Code Case 1441 and the stress index analysis method of the 1969 edition of the piping code USAS B31.7-1969. It is shown that the proposed rules are adequately conservative for those components loaded with a cyclic moment, with the possible exception of girth butt welds where additional test data are needed. It is also pointed out that additional test data are needed for longitudinal welds and for components loaded with combinations of internal pressure and bending moments. (auth)

2117 (TRG-Report–2142) NEW METHODS AND TECHNIQUES IN NUCLEAR MATERIALS SCIENCE, 1970. UKAEA Diffraction Analysis Conference, 18th Meeting, Bournemouth, 12–13 November 1970. Ferguson, I. F. (ed.) (United Kingdom Atomic Energy Authority, Springfields (England). Reactor Group). 1971. 64p. (CONF-701136). UK 70p.

The current status of various new methods and techniques used in nuclear materials science is summarized. Eighteen papers refer, among other subjects, to neutron radiography, x-ray microscopy, the Cameca direct imaging mass analyzer, high voltage electron microscopy, the Stereoscan and its application to irradiated materials, the application of electron probe microanalyzer to irradiated material, computer controlled diffractometers and optical anisotropy measurements (OAF) on pyrocarbon. (auth)

2118 ^{60}Co RADIOGRAPHY. PART II. PHOTOGRAPHIC EFFECT OF ELECTRON KINETIC ENERGY. Splettstosser, H. R. (Eastman Kodak Co., Rochester, N. Y.). Mater. Eval.; 29: No. 9, 205-8(Sep 1971).

By means of narrow-beam ^{60}Co exposures, the relative photographic effect of electrons from photon interactions in various thicknesses of several materials was determined. These exposure conditions resulted in a narrow-beam intensification factor of 30 for aluminum compared with 24 for lead. The radiographic recording of image-forming radiation relative to recording of the lower-energy scattered radiation is discussed in terms of the photographic effect of electrons and the known principles of photon interactions in screen materials. The photographic effect of electrons from various screen materials explains why medium-atomic-number screens are more satisfactory than high-atomic-number screens for ^{60}Co radiography. (auth)

2119 NEUTRON RADIOGRAPHY. Mech. Eng.; 93: No. 7, 21-4(Jul 1971).

A state-of-the-art report on neutron radiography is presented. Information is included on development and uses, neutron sources, and radiographic techniques. (J.R.D.)

2120 BEAM DIVERGENCE CONTRIBUTION TO IMAGE SPREAD IN NEUTRON RADIOGRAPHY. Harms, A. A.; Younis, M. H. (McMaster Univ., Hamilton, Ont.). Trans. Amer. Nucl. Soc.; 14: No. 2, 526-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2121 NEUTRON RADIOGRAPHY INSIDE SMALL REACTORS. Cappadona, Carmelo (Instituto di Applicazioni e Impiante Nucleari, Palermo, Italy). Trans. Amer. Nucl. Soc.; 14: No. 2, 527-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2122 NONDESTRUCTIVE TESTING OF BRAZED JOINTS USING NEUTRON RADIOGRAPHY. Haskins, J. J. (General Electric Co., Pleasanton, Calif.); Hill, K. R.; Tunnell, G. W. Trans. Amer. Nucl. Soc.; 14: No. 2, 528-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2123 OBSERVATION OF CARBURETOR ICING USING NEUTRON RADIOGRAPHY. Reijonen, H.; Jauho, P. (State Inst. for Technical Research, Otaniemi, Finland). Trans. Amer. Nucl. Soc.; 14: No. 2, 529-30(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2124 DEVELOPMENT OF A HIGH-RESOLUTION THERMAL-NEUTRON RADIOGRAPHY FACILITY. Alger, D. M.; Bull, S. R. (Univ. of Missouri, Columbia). Trans. Amer. Nucl. Soc.; 14: No. 2, 530(Oct 1971).

From Joint Meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2125 INHERENT RESOLUTION LIMIT FOR NEUTRON MICRORADIOGRAPHY. Parker, W. L.; Summers, P. A.; Rau, J. A. (Reed Coll., Portland, Oreg.). Trans. Amer. Nucl. Soc.; 14: No. 2, 530-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2126 DEVELOPMENT OF A NEUTRON RADIOGRAPHIC CONTRAST, RESOLUTION, AND SCATTER INDICATOR (CRASI). Tomlinson, R. L.; Newacheck, R. L. (Aerotest Operations, San Ramon, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 531-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2127 HYDROGEN SENSITIVE NEUTRON RADIOGRAPHY. Kosanke, H. D. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 533(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2128 MEASUREMENT OF ANTISCATTER GRID EFFECTIVENESS IN THERMAL-NEUTRON RADIOGRAPHY OF HYDROGENOUS MATERIALS. Rau, J. A.; Parker, W. L. (Reed Coll., Portland, Oreg.). Trans. Amer. Nucl. Soc.; 14: No. 2, 533-4 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2129 IMAGING WITH SCATTERED NEUTRONS: AN ALTERNATE TO NEUTRON RADIOGRAPHY FOR THICK OBJECTS. Harmer, Don S.; Allen, J. Joseph (Georgia Inst. of Tech., Atlanta). Trans. Amer. Nucl. Soc.; 14: No. 2, 534(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2130 MITR NEUTRON RADIOGRAPHY FACILITY. Westberg, E. L.; Collins, K. D.; Gwinn, D. A. (Massachusetts Inst.

of Tech., Cambridge). Trans. Amer. Nucl. Soc.; 14: No. 2, 534-5(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2131 THERMAL-NEUTRON RADIOGRAPHY WITH A SEALED-TUBE NEUTRON GENERATOR AND WATER MODERATOR. Vasilik, Dennis G. (Dow Chemical Co., Golden, Colo.); Murri, Richard L.; Fischer, George P. Trans. Amer. Nucl. Soc.; 14: No. 2, 535-6(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2132 HIGH-INTENSITY, HIGH RESOLUTION NEUTRON RADIOGRAPHY OF NUCLEAR FUELS. Foster, B. E.; Snyder, S. D.; DeCarlo, V. A. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 536-7(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2133 MEASUREMENT OF CAPSULE HEAT TRANSFER GAPS USING NEUTRON RADIOGRAPHY. Thaler, Lawrence A. (Plum Brook Station, Sandusky, Ohio). Trans. Amer. Nucl. Soc.; 14: No. 2, 537-8(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2134 NEUTRON RADIOGRAPHY FOR NUCLEAR FUEL INTERROGATION. Cason, John L. (Gamma Industries, Baton Rouge, La.); Jackson, Charlie N. Trans. Amer. Nucl. Soc.; 14: No. 2, 538-9(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2135 ACOUSTICAL SCANNED HOLOGRAPHY TECHNIQUES FOR VIEWING IN LIQUID-SODIUM REACTORS. Collins, H. Dale (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 727-8(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2136 PUBLIC SERVICE OF COLORADO STEAM GENERATOR AIR FLOW TEST. Kaufman, J. S. (Gulf Energy and Environmental Systems, San Diego, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 786-7(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2137 USE OF HIGH-RESOLUTION GAMMA-RAY SPECTROMETRY FOR DETECTING THE FAILURE OF CLADDING IN ENCAPSULATED FAST REACTOR FUEL PINS. Phillips, J. R.; Schulte, J. W.; Waterbury, G. R. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 885-6(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2138 OPTIMUM PARAMETERS OF A GAMMA-DEFECTOSCOPE WITH ANALOG TREATMENT OF INFORMATION. Pokrovskii, A. V.; Ripp, A. G. (Tomsk Polytechnic Inst., USSR). Defektoskopiya; No. 3, 105-11(1971). (In Russian).
The choice of basic parameters of a gamma-defectoscope depends on the activity level of the radiation source. Allowing for equipment errors, it was shown by calculations that the values of the optimum parameters of a defectoscope, obtained for the tolerance indicated, differ substantially from the true values. There are proposed a choice of methods and a calculation of optimal parameters of a gamma-defectoscope for the analog method of information handling. The optimal parameters of a defectoscope, obtained with allowance for equipment errors, is different from the literature recommendations and should be corrected in the majority of practical cases. (tr-auth)

2139 RADIATION INTROSCOPES FOR QUALITY CONTROL. Gorbunov, V. I.; Sviryakin, D. I.; Bukreev, V. G.; Kolupaev, A. N.; Egorenko, Yu. A. (Tomsk Polytechnic Inst., USSR). Defektoskopiya; No. 3, 112-17(1971). (In Russian).
Methods of radiation introscope techniques are illustrated by block schematic diagrams and discussed. Basic technical characteristics of introscopes are set forth, along with an indication of their merits and their shortcomings. Recommendations are given for their use. Sensitivity curves were constructed using materials of different thickness, such as aluminum and iron. Such curves show that a maximum sensitivity may be obtained by using certain thicknesses of a given translucent material; for steel 12 to 18 mm represents the optimum thickness. (K.S.W.)

2140 ACCELERATOR-PRODUCED BREMSSTRAHLUNG FOR NONDESTRUCTIVE TESTING. Gorbunov, V. I.; Pokrovskii, A. V.; Moroz, P. S. (Tomsk Polytechnic Inst., USSR). Defektoskopiya; No. 3, 117-23(1971). (In Russian).
Technical and economic criteria are discussed for various types of accelerators in their potential applicability in radiation defectoscopy: betatrons, microtrons, and linear accelerators. The ranges in operating conditions under consideration were: 9 to 30 MeV maximum energy in the bremsstrahlung spectrum, 300 to 3,000,000 R/hr dose rate, 0.025 to 0.15 hr exposure time, and a steel thickness of 100 to 500 mm. The interdependence of parameters such as capacity, dose rate, and sensitivity is illustrated by families of curves. (K.S.W.)

Radioactive Material Handling

Refer also to abstracts 1983, 2242, 2481, and 3963.

2141 (AERE-R-5357) LABORATORY FOR CHEMICAL REMOTE HANDLING. Experience in Handling HTR Fuel. Brown, P. E. (Atomic Energy Research Establishment, Harwell (England)). Mar 1971. 23p. Dep. NTIS (U. S. Sales Only).
Details are given of the modifications carried out in order to modernize two existing concrete cells, and of the equipment and techniques subsequently used in these cells during the post irradiation examination of H.T.R. fuels. (auth)

2142 (BLG-445) REPRESENTATION OF FINE CONTROL IN FABRICATION PROCESSES. Cocquyt, G.; Hecq, R. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). May 1971. 37p. (In French). Dep. NTIS (U. S. Sales Only).
A description is given of a plant for fabrication of mechanical devices using signal flow graphs, and z-transforms of sampled functions of time. The method is used to establish management methods as illustrated by a real case (manufacturing of fuel elements for the BR2 reactor in M.M.N.). It is shown that by using these methods efficient control for safeguard purposes is possible. Algorithms which can be used for the management of such plants are explained. Calculus with recursive formulas and their z-transform transfer functions are performed for clarification and generalization. (auth)

2143 (DPSPU-69-124-1(Suppl.)) SAFETY SUMMARY REPORT: LMF CASK. (Packaging of Radioactive and Fissile Materials). Final Report. Langhaar, J. W.; Scaggs, R. A. (comps.) (Du Pont de Nemours (E.I.) and Co., Aiken, S. C. Savannah River Plant). Oct 1971. Contract AT(07-2)-1. 36p. Dep. NTIS.
Safety Summary Report DPSPU 69-124-1 is revised to permit shipment of 350,000 curies of cobalt-60 (maximum) in LMF casks in compliance with AEC Manual Chapter 0529 (AECM 0529), Safety Standards for the Packaging of Radioactive and Fissile Materials. (auth)

2144 (GAT-T-1745) SHIPMENT OF 8-INCH I. D. CYLINDERS OF UF_6 AT ENRICHMENTS TO 97.65 PERCENT ^{235}U AND 12-INCH I. D. CYLINDERS OF UF_6 AT ENRICHMENTS TO 30.00 PERCENT ^{235}U AT LIMITED MODERATION: AND SUBSEQUENT CYLINDER CLEANING. Feuerbacher, J. L. (Goodyear Atomic Corp., Piketon, Ohio). 14 Oct 1971. Contract AT(33-2)-1. 21p. (CONF-711009-8). Dep. NTIS.
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971).
On the basis of experimental data and computer calculations for a UF_6 purity of 99.5%, 8-inch ID nickel or monel cylinders are safe at enrichments to 97.65 wt % ^{235}U, and 12-inch ID nickel or monel cylinders are safe to 30% ^{235}U enrichment; 250 pounds of UF_6 may be contained in an 8-inch ID cylinder, and 450 pounds in a 12-inch ID cylinder, compared to 55 pounds in 5-inch ID × 30-inch cylinders, thus leading to substantial savings in cylinder inventory, handling, sampling, and analytical costs. These larger cylinders may be shipped in cylindrical packages of very nearly the same diameters as for 5-inch ID cylinders. Proof of individual safety of these cylinders at the higher enrichments is based on comparison with critical experiments. Based on the present AEC criteria, computational proof is presented of the nuclear criticality safety and radiational safety of shipping reasonably large numbers of these cylinders at the designated enrichments. The sensitivity of arrays of such packages to small variations in spacing, increments in numbers, and concrete array reflection were also investigated. The results with the concrete array-reflector are of considerable concern, since $K_{effective}$ is markedly increased, as compared to water array-reflection. Safe methods of wet decontamination of these cylinders have also been investigated by means of hand calculations and available computer results, making use of heel size limits, boric acid for neutron absorption, and non-reflection, as controls. Indications are that safety can be assured for wet decontamination of both sizes of cylinders. (auth)

2145 (LA-DC-12740) TRITIUM LOSS FROM COATED CEMENT PASTE BLOCKS. Emelity, L. A.; Christenson, C. W.; Wanner, J. J. (Los Alamos Scientific Lab., N. Mex.). [1971]. 23p. (CONF-710809-5). Dep. NTIS.

From Tritium symposium; Las Vegas, Nev. (30 Aug 1971).

An investigation of parameters associated with disposal of tritium as tritiated water in cement blocks is described. Coatings essential to containment of the waste were evaluated. Initial results indicate that a reasonably effective external barrier can be formed using asphalt, paraffin, or beeswax. Continued and more extensive research is shown to be needed. (J.R.D.)

2146 (NLCO-1086) CRITICALITY SAFETY EVALUATION OF SLIGHTLY ENRICHED URANYL NITRATE CRYSTALS IN VERMICULITE SHIPPING CONTAINERS. Dunaway, D. L.; Whitesides, G. E. (National Lead Co. of Ohio, Cincinnati). 3 Nov 1971. Contract AT(30-1)-1156. 6p. Dep. NTIS.

The evaluation indicates that 770 units, containing ≤12 kg of ≤10% ^{235}U as uranyl nitrate crystals, would be adequately subcritical. Variations in the density of vermiculite have no significant effect on the results; hence, accidental loss of it would not be a criticality problem. Packaging the corrosive uranyl nitrate crystals in polyethylene jars does not affect k_{eff} significantly. Since the 770-unit array is safe, the minimum transport index for Fissile Class II shipments is 0.4. Up to 385 containers may be shipped as Fissile Class III in an exclusive use vehicle. (auth)

2147 (ORNL-TM-3505) TRU TEN-TON CALIFORNIUM SHIPPING CONTAINER. Klima, B. B.; Shappert, L. B. (Oak Ridge National Lab., Tenn.). Nov 1971. Contract W-7405-eng-26. 41p. Dep. NTIS.

The TRU Ten-Ton Californium Shipping Container (DOT Special Permit No. 5740) was designed to transport large quantities of any isotope of americium, curium, berkelium, californium, einsteinium, and fermium in the solid form. Descriptions are presented of the container, its operating characteristics and procedures. An analytical evaluation is included to demonstrate compliance with the regulations governing packages in which radioactive material is shipped. Computational procedures were used to determine the structural integrity and thermal behavior of the container with respect to the general standards for packaging, structural standards, standards for normal conditions of transport, and the standards for the hypothetical accident conditions. Results of this evaluation show that the container complies with all the applicable regulations. (auth)

2148 (RFP-1585) MODELS FOR THE SAFE STORAGE OF FISSILE METAL. Altschuler, Sidney J.; Schuske, C. Lee (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 24 Sep 1971. Contract AT(29-1)-1106. 21p. Dep. NTIS.

Two models are described for calculating critically safe storage configurations for uranium (93.4% uranium-235) and plutonium (96% plutonium-239, 4% plutonium-240) metal. The first model deals with conventional arrays in air of fissile units surrounded by concrete walls. The model uses the concepts of surface density and unit surface-to-volume ratio to define safe-array parameters. The second model makes use of thick internal moderators (i.e., water), enclosing each storage unit in an array. These arrays are also surrounded by concrete walls. The internal moderators partially isolate adjacent storage units from one another and thus, in some cases, permit extremely high surface densities and vault loading. A discussion of the models is preceded by a calculational analysis of many factors that influence the models, such as the shape and density of the unit and the degree of reflection of arrays of units. Given also are examples to illustrate the effective use of the models. (auth)

2149 (RT/PROT-(70)40) PROGRAM ESTER: SOLIDIFICATION OF LIQUID WASTE OF HIGH ACTIVITY. CHARACTERISTICS OF PHOSPHATE GLASS MELTS PREPARED FROM SIMULATED FISSION-PRODUCTS SOLUTION. Bocola, W.; Donato, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 4 Jan 1971. 50p. (In Italian). Dep. NTIS (U. S. Sales Only).

Thirty-three different phosphate-glass melts were prepared from a simulated fission products solution. The fission product oxide content varied from 3.4 to 19.3 (weight%). For each melt physical properties such as density, operating temperature, and solubility in distilled water at 25 and 95°C, were measured and reported. Some of the prepared melts were dense, low softening, and insoluble, the main characteristics being the following: fission products oxide content 8 to 13 (weight%), $\Sigma M^{+}/p = 1$, density 2.8 to 3.5 g/cm^3, operating temperature 650 to 800°C, and leaching factor 10^{-6} to 10^{-7} g/cm^2 day. (auth)

2150 (SZS-8/71) SAFETY ASPECTS OF BITUMINIZATION OF RADIOACTIVE WASTES. Koerner, W.; Dagen, A. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Apr 1971. 26p. (In German). Dep. NTIS (U. S. Sales Only).

After an introductory review of the literature on radiation resistance of bitumens, leaching, and redox reactions, the results of some investigations on these problems are presented. The hydrogen formation and expansion rates caused by external gamma and internal beta irradiation of bitumen B 45 and bitumen B 45–$NaNO_3$ mixtures are given. The leaching rates for between B 45–$NaNO_3$ and cement–$NaNO_3$ mixtures are presented. It was found by thermal analysis that in bitumen B 45–$NaNO_3$ mixtures (40% $NaNO_3$) redox reactions occur above 300°C. (auth)

2151 METHODS FOR THE ASSESSMENT OF PACKAGING FOR THE TRANSPORT OF RADIOACTIVE MATERIALS. PART 1. MATERIALS OTHER THAN LARGE RADIOACTIVE SOURCES AND FISSILE MATERIALS. BS 3895 Pt. 1 1965. London; British Standards Institution (1965). 12p. Available from American National Standards Institute, New York.

A standard is described in which methods used to test the suitability of radioactive materials packaging for transport are specified. (J.R.D.)

2152 WATER TREATMENT IN THE SEVENTIES. Proceedings of a Symposium Held at Reading, England, January 5–7, 1970. West St. Chesterfield, Eng.; North Derbyshire Water Board (1970). 181p. (CONF-700118).

Twelve papers were presented at the Symposium of which one was in scope for NSA and for which a separate abstract was written. (UK)

For an abstract of an individual paper see: 2153.

2153 DISPOSAL OF SOLID AND LIQUID WASTES. Burns, R. H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 177-93 of Water Treatment in the Seventies. West St. Chesterfield, Eng.; North Derbyshire Water Board (1970).

From Symposium on water treatment in the seventies; Reading, England (5 Jan 1970). See CONF-700118.

Methods of disposing of radioactive wastes are discussed. For low and intermediate level radioactive liquid effluents, chemical precipitation processes may be used. The importance of volume reduction is stressed and the freeze-thaw technique developed for this at AERE Harwell described. The use of vermiculate as the adsorbent on the walls of a basket centrifuge system for decontamination of radioactive effluents is mentioned, and the Oak Ridge Laboratory's technique of hydrofracturing, used in the disposal of certain radioactive aqueous solutions, described. The necessity for dumping any radioactive waste disposed of in the sea beyond the continental shelf, in solid form is noted. Techniques involved in incorporating radioactive wastes into bitumen prior to disposal are described, the advantages of this technique discussed and unsuitable materials mentioned. The suggestion that nuclear devices could be used to create waste disposal caverns in the USA is also noted. (UK)

2154 METHODS FOR THE ASSESSMENT OF PACKAGING FOR THE TRANSPORT OF RADIOACTIVE MATERIALS. PART 2. FISSILE MATERIALS AND LARGE SOURCES. BS 3895 Pt. 2 1968. London; British Standards Institution (1968). 56p. Available from American National Standards Institute, New York.

Methods that may be used to test for vibration and pressure suitability of packaging for the transport of radioactive materials are specified. In particular, packaging used for large radioactive sources and for fissile materials complying with the criteria for Fissile Class I and Class II in the IAEA regulations is discussed. (P.C.H.)

2155 GLOVE BOX TURNTABLE CAM ROTATING MECHANISM. Duncan, Richard D. (to United States Atomic Energy Commission). U. S. Patent 3,587,333. 28 Jun 1971. Filed 9 Jan 1970.

A mechanism for rotating a glove box turntable through a predetermined angle is described which includes a guide tube having upper and lower portions each containing a plurality of linear grooves. The linear grooves in the lower portion are offset from the linear grooves in the upper portion. Each of the upper and lower portions of the guide tube has a plurality of wedge grooves intersecting the linear grooves in both the upper and lower portions. A shaft, positioned within the guide tube, is connected to the glove box turntable and includes a pin inserted in one of the linear grooves in the lower portion. Moving the shaft along the guide tube causes the pin to move along the linear groove in the lower portion to engage a wedge groove in the upper portion of the guide tube. The wedge groove moves the pin which causes the shaft to rotate through part of the predetermined angle to a linear groove in the upper portion of the guide tube. Moving the shaft in the reverse direction causes the pin to engage a wedge groove in the lower portion which moves the pin so as to rotate

the shaft through the remainder of the predetermined angle back to a linear groove in the lower portion. (Official Gazette)

2156 SAFETY DEVICE FOR SEALING ENCLOSURES. Fedi, Leto; Meunier, Jean; Vertut, Jean (to Commissariat a l'Energie Atomique). French Patent 2,040,616. 11 Jan 1971. Filed 4 Apr 1969. (In French).

A safety device for opening and closing the sealed junction between two adjacent enclosures is described. The system consists of a strap from the first enclosure, which is provided with an external moving ring and seals the second enclosure, an internal moving ring, and an external extraction ring. (France)

2157 IMPROVEMENTS TO MULTICHANNEL DISTRIBUTORS. (to Saint-Gobain Techniques Nouvelles SA). French Patent 1,602,686. 11 Jan 1971. Filed 6 Sep 1968. (In French).

An invention is described which concerns a multichannel distributor for shunting a noxious liquid, especially a radioactive flowing liquid from a source towards one of the receptacles of an assembly. The body of the distributor receives one or several input liquid pipes which are connected to the source. Ferrules provided with an opening at a predetermined level, and extended by a pipe leading to an overflow or one of the receptacles, are fixed to the body of the distributor. This body is divided by partition walls into communicating cavities. The first cavity receives the input liquid pipe; a tube and a ferrule are connected to the overflow. Each of the other cavities is connected to one of the receptacles by a ferrule followed by a tube in which a gas separator is interposed. The only mechanical part of the distributor considered as the invention is the shut-off devices interposed between the tubes and the two gas sources of the separator. These devices can be placed as far away as desired from the source and the liquid receptacle. The connection between the distributor and the sources can be effected using small diameter pipes, which are easily positioned because of the low gas consumption of the separator. (france)

2158 STUDY OF A GAUSSIAN STOCHASTIC MODEL FOR THE DETECTION OF A DIVERSION OF FISSILE MATERIAL. Servais, F.; Goldschmidt, P. (Belgonucleaire, Brussels). J. Nucl. Energy; 25: No. 8, 347-59(Aug 1971). (In French).

A stochastic model is described for the quantitative assessment of the efficiency of safeguards operations in reprocessing or fabrication plants. The a priori assumption, or zero hypothesis, is that there has been no diversion of fissile materials. This zero-centered model seems more adequate than a deviation centered model. The latter is shown to lead to unacceptable statements, whereas the former makes improper charges of diversion impossible. To detect diversion adequately, three criteria are adopted: the first sets an upper limit M for the total mass uncertainty; when the latter reaches M a complete inventory is taken; the second makes it possible to decide whether or not an estimated mass balance is compatible with the agreed model; the third connects the mass uncertainty to the time it lasts and also settles the number of strategic points within the plant. As an application of the mathematical model developed, systematic cheating strategies are also studied. (UK)

2159 IN-SITU INCORPORATION OF NUCLEAR WASTE IN DEEP MOLTEN SILICATE ROCK. Cohen, J. J.; Lewis, A. E.; Braun, R. L. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc.; 14: No. 2, 468(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2160 COST OPTIMIZATION OF SAFEGUARDS IN THE FUEL CYCLE. Tillman, F. A.; Costanzi, F. A.; Chatterjee, S. (Kansas State Univ., Manhattan). Trans. Amer. Nucl. Soc.; 14: No. 2, 492(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2161 MODEL FOR THE ECONOMIC ANALYSIS OF HIGH-LEVEL RADIOACTIVE WASTE MANAGEMENT. Dillon, R. S. (Union Carbide Corp., Oak Ridge, Tenn.); Perona, J. J.; Blomeke, J. O. Trans. Amer. Nucl. Soc.; 14: No. 2, 495(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2162 THERMAL CONSIDERATIONS IN THE PROPOSED NATIONAL RADIOACTIVE WASTE REPOSITORY. Cheverton, R. D.; Turner, W. D. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 496(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2163 OPTIMIZATION OF A MATERIALS SAFEGUARDS SAMPLING. Bouchey, G. D.; Beightler, C. S.; Koen, B. V. (Univ. of Texas, Austin). Trans. Amer. Nucl. Soc.; 14: No. 2, 664-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2164 NUCLEAR CRITICALITY OF INTERSECTING CYLINDERS OF $U(5)O_2F_2$ AQUEOUS SOLUTION. Johnson, E. B. (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 678(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2165 CRITICALITY CONSIDERATIONS IN THE NON-DESTRUCTIVE ASSAY OF NUCLEAR MATERIAL. Smith, D. B.; Forster, R. A.; Thorpe, M. M. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 678-80(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2166 CRITICALITY SAFETY CONSIDERATIONS IN THE FABRICATION OF UO_2 AND PuO_2–UO_2 FUELS FOR LIGHT-WATER REACTORS. Brown, C. L. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 681(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2167 CRITICALITY SAFETY ANALYSIS OF AN LWR FUEL ASSEMBLY SHIPPING CONTAINER. Fass, E. (Gulf United Nuclear Fuels Corp., Elmsford, N. Y.); Kropp, R. Trans. Amer. Nucl. Soc.; 14: No. 2, 682-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2168 CRITICALITY SAFETY CONSIDERATIONS IN THE DESIGN OF A LARGE CONCRETE STORAGE ARRAY FOR PLUTONIUM OXIDE–URANIUM OXIDE FUEL SUBASSEMBLIES. Brown, C. L.; Davenport, L. C. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 683-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2169 CRITICALITY SAFETY EXPERIENCE UNDER A BROAD LICENSE. Borden, W. C.; Dawson, D. M. (General Electric Co., Wilmington, N. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 684-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2170 SHIPMENT OF 8-in.-i.d. CYLINDERS OF UF_6 AT ENRICHMENTS TO 97.65 PERCENT ^{235}U, AND 12-in.-i.d.-CYLINDERS AT ENRICHMENTS TO 30.00 PERCENT ^{235}U, AT LIMITED MODERATION; AND SUBSEQUENT CYLINDER CLEANING. Feuerbacher, J. L. (Goodyear Atomic Corp., Piketon, Ohio). Trans. Amer. Nucl. Soc.; 14: No. 2, 685-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2171 RADIOACTIVE WASTE MANAGEMENT AND RADIATION EXPOSURE. Goldman, Morton I. (NUS Corp., Rockville, Md.). Trans. Amer. Nucl. Soc.; 14: No. 2, 774-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2172 HOT FUEL EXAMINATION FACILITY (HFEF). Swanson, N. J. (Argonne National Lab., Idaho Falls, Idaho); White, J. R.; Mingesz, D. P. Trans. Amer. Nucl. Soc.; 14: No. 2, 869 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2173 TRANSFER PENETRATIONS AND EQUIPMENT FOR THE HFEF CELL COMPLEX. Kann, W. J. (Argonne National Lab., Ill.); Brak, S. B.; White, J. R. Trans. Amer. Nucl. Soc.; 14: No. 2, 869-70(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2174 EQUIPMENT DECONTAMINATION, MAINTENANCE, AND WASTE TRANSFER PROVISIONS IN THE HFEF. White, J. R.; Taylor, D. S. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: No. 2, 870-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2175 INERT-ATMOSPHERE HOT CELLS FOR THE EXAMINATION OF IRRADIATED U-Pu FUEL ELEMENTS. Mason, P. A. Jr.; Frantz, C. E.; Montgomery, C. D. (Los Alamos Scientific

Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 871-2 (Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2176 TREAT LOOP OPERATIONS WITH A NITROGEN GLOVE BOX FOR HANDLING PLUTONIUM-BEARING SPECIMENS. Willis, F. L.; Schmidt, K. J.; Dickerman, C. E.; August, C. .(Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 872(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2177 ECONOMIC AND SOCIOLOGICAL IMPACT OF INDUSTRIAL ROBOTS. Engelberger, J. F. Trans. Amer. Nucl. Soc.; 14: No. 2, 873(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2178 DEVELOPING MODULAR INDUSTRIAL ROBOT. Macphee, John (AMF Versatran, Stamford, Conn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 873-4(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2179 PHILOSOPHY OF USING A BIT-ORIENTED MINICOMPUTER TO INCREASE THE EFFICIENCY AND FLEXIBILITY OF REMOTE SYSTEMS. Seeberger, F. G.; Appelt, Daren (Texas Instruments Inc., Houston, Tex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 874-5(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2180 REMOTE HANDLING STUDIES AT ROCKY FLATS. Sheldon, O. L. (Dow Chemical Co., Golden, Colo.). Trans. Amer. Nucl. Soc.; 14: No. 2, 875(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2181 MECHANICAL UPGRADING OF INDUSTRIAL ROBOTS. Aldred, J. K.; Latta, L. L.; Orr, J. A.; Ramer, P. C.; Zybura, J. G. (Dow Chemical Co., Golden Colo.). Trans. Amer. Nucl. Soc.; 14: No. 2, 875-6(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2182 ELECTRICAL UPGRADING OF INDUSTRIAL ROBOTS. Belcher, J. V.; Remley, L. A.; Ramer, P. C. (Dow Chemical Co., Golden, Colo.). Trans. Amer. Nucl. Soc.; 14: No. 2, 876-7 (Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2183 MAINTENANCE CONSIDERATIONS IN ROBOT-SERVED FACILITY. Belcher, J. V.; Bert, J. D.; Orr, J. A. (Dow Chemical Co., Golden, Colo.). Trans. Amer. Nucl. Soc.; 14: No. 2, 877(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2184 DESIGN CRITERIA FOR IN-CELL METALLOGRAPH STAGES. Cochran, F. L.; Hilbert, A. S.; Mattson, P. T. (Gulf Energy and Environmental Systems, San Diego, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 878-9(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2185 ELECTRON MICROSCOPY SPECIMEN PREPARATION IN A HOT CELL. Chandler, T. L; DuBose, C. K. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 881-2(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2186 ALPHA-GAMMA RADIOMETALLURGY LABORATORY AT CASACCIA NUCLEAR CENTER: DESIGN AND CONSTRUCTION. Cesarano, C.; Cudia, B.; Evangelisti, R.; Lauro, M.; Vescia, G. (CNEN, Rome). Trans. Amer. Nucl. Soc.; 14: No. 2, 883(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2187 CONCEPTUAL DESIGN OF THE FFTF INTERIM EXAMINATION/MAINTENANCE CELL. Harbison, S. G. (Aerojet Nuclear Systems Co., Sacramento, Calif.); Graham, D. W.; Garrett, E. E. Trans. Amer. Nucl. Soc.; 14: No. 2, 883-4(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2188 REMOTE FACILITY FOR SPENT-FUEL SHIPPING CASK DECONTAMINATION. Albrecht, W. L.; Andrews, T. B. (Tennessee Valley Authority, Knoxville). Trans. Amer. Nucl. Soc.; 14: No. 2, 884(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2189 REQUALIFICATION EXAMINATION OF IRRADIATED FERMI SUBASSEMBLIES. Matte III, J. (Atomic Power Development Associates, Inc., Detroit). Trans. Amer. Nucl. Soc.; 14: No. 2, 884-5(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2190 DEMOUNTABLE GLOVE BOX. Bertoni, Bruno; Delfosse, Jean (to Commissariat a l'Energie Atomique). French Patent 2,053,447. 5 Apr 1971. Filed 4 Jul 1969. (In French).
A glove box intended for the handling of radioactive products is described. It is constructed of demountable panels (two at a time) on a square framework. One side of the framework is provided with a longitudinal flange with threaded holes at regular intervals; the connecting bars are held rigidly by bolts screwed into these holes. A sealing ring is inserted between the framework and the panels. (France)

2191 PROCESS FOR AUTOMATICALLY TRANSFERRING SAMPLES AND AN APPLICATION OF THIS PROCESS. Fremion, Lucien (to Commissariat a l'Energie Atomique). French Patent 2,053,665. 5 Apr 1971. Filed 11 Jul 1969. (In French).
A device for automatically transferring liquid or powdered samples contained in plastic bottles is described; applications to the analysis of short-lived radioisotopes are envisaged. The container consists of a cylindrical bottle holder with radial fins surrounding the bottle and the holder. The base of the support is provided with aeration openings and the upper part of the container is shielded by a lid also provided with aeration openings and an aperture for the sampling needles. The conveyor and the valves are moved by electromagnets. The useful part of the radioactive liquid is selected using an ion exchange resin. (France)

2192 DEVICE FOR INITIATING AN EXOTHERMIC REACTION. Meneret, Jean (to Commissariat a l'Energie Atomique. Societe Desmarquest SA). French Patent 2,053,396. 5 Apr 1971. Filed 3 Jul 1969. (In French).
A device for initiating the exothermic reactions involved in U and Pu refining processes using Ca and Mg is described. A rod of refractory material supports the ball above the reacting mass. A loop of wire, fusible at a given temperature encircles the ball and retains it on the rod. An oven is used to heat the ball, which subsequently melts the wire, causing the ball to fall into the mass, thereby initiating the reaction. The wire loop is incorporated in a relay circuit, which is actuated when the wire fuses and switches off the heating. (France)

2193 PULVERULENT MATERIAL FEEDING DEVICE OF A PRESS. Teboul, Albert (to Commissariat a l'Energie Atomique. Societe de Fabrication d'Elements Catalytiques). French Patent 2,041,014. 29 Jan 1971. Filed 30 Apr 1969. (In French).
Pulverulent material feeding device for a press provides successive powder charges having constant weight. The apparatus comprises a means for progressively pouring the pulverulent material into a continuously weighed vessel, and a means for stopping the powder flow in the vessel, inverting it automatically in the matrix chamber, and repeating automatically the same cycle synchronously with the press operation. This apparatus was developed in order to manufacture uranium oxide or mixed U–Pu oxide pellets for fuel elements. (France)

2194 IMPROVEMENTS TO THE METHODS AND INSTALLATIONS FOR THE MOUNTING OF SEALED RINGS AND ANALOG DEVICES IN RADIOACTIVE ENCLOSURES. Townsend, Eric (to Commissariat a l'Energie Atomique). French Patent 2,045,100. 15 Feb 1971. Filed 30 May 1969. (In French).
A process is described concerning mounting of extensible rings with articulated elements, and is designed to ensure the biological sealing of the entrance of radioactive enclosures. The extensible ring is protected against shocks by projecting parts. These parts can be radially displaced when a new extensible ring is fitted. (France)

2195 FUNDAMENTAL PRINCIPLES FOR PROTECTION IN THE DESIGN AND CONSTRUCTION OF INSTALLATIONS FOR WORK ON UNSEALED RADIOACTIVE MATERIALS. ISO R 1710 1970(E). International Organization for Standardization (1970). 10p. Available from American National Standards Institute, New York.
Recommendations are made for the safe design and construction

of facilities for working on unsealed radioactive materials of high, medium, or low activity. Information is included on general radiation protection principles, arrangement of work areas, ventilation, handling of radioactive wastes, monitoring and health physics equipment and facilities, selection and use of materials, and general safety provisions. (L.C.L.)

Vacuum Engineering

2196 (CEA-CONF-1858) TITANIUM EVAPORATION PUMP, ITS APPLICATION TO NUCLEAR FUSION EXPERIMENTS AND SPACE SIMULATION. Prevot, F.; Sledziewski, Z. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1970]. 32p. (CONF-711005-4). Dep. NTIS (U. S. Sales Only).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

The performance of low-temperature Ti evaporation pumps is briefly discussed (getter capacity of about 10^{16} mol/cm^2, limiting vacuum (10^{-10} torr). An apparatus intended for a magnetic mirror configuration and space simulation chambers equipped with Ti evaporation pumps are described. (France)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 1780 and 1781.

General Detectors and Monitors

Refer also to abstracts 2361, 2396, 3663, 3795, 3869, 3876, and 3955.

2197 (AERE-M-2453) FISSION CHAMBERS AS SECONDARY STANDARDS FOR NEUTRON FLUX DENSITY MEASUREMENTS. Leake, J. W. (Atomic Energy Research Establishment, Harwell (England)). Jul 1971. 10p. Dep. NTIS (U. S. Sales Only). UK 9p.

Fission chambers to be used as secondary standards for the measurement of neutron flux density have been designed and manufactured. Each chamber has a high and a low sensitivity section (containing 42 mg and 8 mg of uranium, respectively). (auth)

2198 (CEA-N-1437) TESTS ON SOME NEW LIQUID SCINTILLATORS. Chevalier, Michel; de Choudens, Henri; Guerin, Paul (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jun 1971. 15p. (In French). Dep. NTIS (U. S. Sales Only).

Some new compositions of liquid scintillators for ^{14}C or ^{3}H counting were investigated. The following compositions PBD, butyl PBD, Dm POPOP, and triton X 100 were tested. It was found that toluene, PDP and Dm POPOP compositions are best for ^{14}C counting while for aqueous ^{3}H samples the best scintillators are: toluene, PPO, Dm POP, Triton X 100, dioxane, PBD, Dm POPOP, napthalene or ethanol. (France)

2199 (CEA-N-1442) ESTIMATION OF THE COUNTING EFFICIENCY OF A CYLINDRICAL NaI(Tl) SCINTILLATOR. Buxerolle, Michel (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). May 1971. 40p. (In French). Dep. NTIS (U. S. Sales Only).

The use of NaI(Tl) crystal detectors in conjunction with point sources, disk sources, or cylindrical sources is discussed, with corrections for γ absorption being taken into consideration. The efficiency and the peak/total ratio are calculated using Monte-Carlo methods. The results obtained are in good agreement with theoretical and experimental values published by other workers. (France)

2200 (CEA-R-4160) ACTIVITY MEASUREMENTS ON LOW CONCENTRATION RADIOACTIVE GAS IN AIR. Amoudry, Francois (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Jul 1971. 66p. (In French). Dep. NTIS (U. S. Sales Only).

Counting equipment for measuring the volumetric activity of certain gaseous fission products (^{133}Xe, ^{85}Kr) is described. Two methods using the same equipment and control techniques were developed: the absolute indirect method which is applicable to a mixture of two or several gases, and the absolute direct method which can be used to measure the volumetric activity of a pure gas. Comments are made on the various experiments performed. The quality of the results obtained by these methods is discussed. (France)

2201 (CONF-710705-9) SCINTILLATION BETA DETECTORS FOR RAPID MEASUREMENT OF SPECIFIC VOLUME ACTIVITY OF AQUEOUS MEDIA AND GASES. Artemenkova, L. V.; Kazanskaya, V. A.; Petrusev, S. S.; Sokolov, A. D.; Fedorovskiy, Yu. P. [1970]. 13p. Dep. NTIS (U. S. Sales Only).

From International symposium on rapid methods for measuring radioactivity in the environment; Munich, Germany (5 Jul 1971).

The design, fabrication, and testing of several types of plastic-scintillator beta detectors for rapid measurement of small-specific-volume activities of aqueous media and gases are described. Data on the sensitivity and threshold sensitivity and block diagrams are given. From this work several devices were developed for radiation monitoring of water (both samples and blowing), bottom deposits, vegetation, and food products. Due to their high threshold sensitivity these detectors can be used, not only for purposes of monitoring, but also for investigation of various types of problems in hydrological and hydrogeological studies using radioactive tracers. (R.W.R.)

2202 (CONF-710705-10) OPERATIONAL MONITORING OF RADIOACTIVE LIQUID MEDIA BASED ON GAMMA-RADIATION. Isakov, L. M.; Novikov, B. V.; El'tsin, G. I. Translated from International Symposium on Rapid Methods for Measuring Radioactivity in the Environment; Munich, Germany, 5 Jul 1971. 8p. Dep. NTIS (U. S. Sales Only).

A matrix method for calibrating gamma radiometers for liquids is presented, and a scintillation detector system for monitoring water and marine life is briefly described. (W.H.K.)

2203 (CONF-710705-11) CONTROL OF RADIOACTIVE AEROSOLS IN UTILITY DISCHARGES AND IN THE ENVIRONMENT. Bolotin, V. F.; Zalmanzon, Yu. Ye.; Kamyshchenko, V. D.; Chutkin, O. A.; Nikitin, A. N. [1970]. 14p. Dep. NTIS (U. S. Sales Only).

From International symposium on rapid methods for measuring radioactivity in the environment; Munich, Germany (5 Jul 1971).

Various instruments for the monitoring of radioactive aerosols are briefly described. (W.H.K.)

2204 (CONF-711111-5) BROADBAND CURRENT PREAMPLIFIER CONFIGURATION FOR OBTAINING HIGH-RESOLUTION ENERGY AND TIME INFORMATION FROM NUCLEAR RADIATION DETECTORS. Millard, J. K.; Blalock, T. V.; Hill, N. W. (Oak Ridge National Lab., Tenn.). [1971]. 13p. Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

A broadband current preamplifier was developed to complement nuclear spectroscopy systems requiring linear gating. The preamplifier stage configuration consists of an FET input, a broadband interstage current gain section, and a high-impedance feedback network. The preamplifier produces a noise line width comparable to charge-sensitive designs having similar parameters. Because of large bandwidths and low-noise performance, the preamplifier, connected directly to a fast leading-edge discriminator, generates very accurate timing data. A preamplifier consisting of three gain stages was built and subsequently tested with Ge(Li) detectors. This preamplifier had a current gain of 10,000, a rise time of 8 nsec with a 10 pF detector capacitance, and a 0-pF noise line width, using an RC-RC ungated filter, of 1.4 keV (fwhm Ge). With the preamplifier operating from a 10 cc Ge(Li) coaxial detector, timing experiments utilizing the ^{60}Co gamma cascade indicated resolutions as low as 1.15 nsec fwhm. (auth)

2205 (JAERI-1209) NEW METHOD OF DOSE EVALUATION BY SPECTRUM DOSE CONVERSION OPERATOR AND DETERMINATION OF THE OPERATOR. Moriuchi, Shigeru (Japan Atomic Energy Research Inst., Tokyo). 9 Oct 1970. 39p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Evaluation of radiation dose from pulse-height spectrum measured with a NaI(Tl) scintillation counter or other radiation detectors has been done by calculation from the incident radiation flux which is obtained by spectrum analysis, but it is not easy to utilize the method because of difficult problems involved in the analysis. A new method of dose evaluation by the Spectrum-Dose conversion operator is very simple, because radiation dose can be evaluated directly from the observed pulse-height spectrum by applying an operator to the spectrum itself. The details of this method are described concentrating on determination of the operational function G(E) from the point of view of exposure measurements with NaI(Tl) scintillators. Tables of numerical values of G(E) functions of NaI(Tl) scintillators of $1'' \phi \times 1''$ to $6'' \phi \times 6''$, which were calculated using an electronic computer, are also given. (auth)

2206 (JINR-P13-6018) METHOD FOR COUNTING LOSSES MEASUREMENTS USING LIGHT DIODES. Kuptsov, A. V.; Khazins, D. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

The direct method for measurements of counting losses, which take place in complicated registering apparatus, including scintillation and Cherenkov counters, is proposed. The main point of the method is simulation by light diodes of events for which the registering apparatus is aimed. The number of counting losses is given by the fraction of simulated events lost during registration. The application of the method is illustrated. Possible systematic errors and limitations are discussed. (auth)

2207 (JINR-P13-6032) MULTIPLEX MAGNETIC SPECROMETER OF CHARGED PARTICLES. Soroko, L. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

The construction of the multiplex magnetic spectrometer of

charged particles is described. The principle of operation is given and its advantages, as compared to the traditional spectromer scheme, are pointed out. The algorithm of the data processing is formulated. (auth)

2208 (LBL-320) SOME ASPECTS OF X-RAY FLUORESCENCE SPECTROMETERS FOR TRACE ELEMENT ANALYSIS. Landis, D. A.; Goulding, F. S.; Jarrett, B. V. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1971. Contract W-7405-eng-48. 25p. (CONF-710930-1). Dep. NTIS.

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

The application of pulsed-light feedback to low-energy x-ray semiconductor spectrometers is discussed with respect to the energy resolution and counting rate performance. The use of a guard-ring detector and appropriate circuits to reduce background counts and thereby enhance sensitivity of x-ray fluorescence analysis is also discussed. (auth)

2209 (ORNL-TM-3519) CALCULATED PERTURBATIONS IN THRESHOLD FOIL MEASUREMENTS DUE TO NEUTRON INTERACTIONS IN B_4C SHELLS. Ford III, W. E.; Gillen, J. S. (Oak Ridge National Lab., Tenn.). 3 Sep 1971. Contract W-7405-eng-26. 65p. Dep. NTIS.

Calculations were made to determine expected perturbation effects to the measured neutron flux in B_4C shielded threshold foils resulting from neutron interactions in the B_4C. Results indicated that there is a significant increase in the measure flux below the source energy of monoenergetic neutron beams due to scattering. The activities in a series of threshold foils encased within a B_4C shell were calculated for exposure of the shell to monoenergetic 13.57- and 1.01-MeV neutron beams incident at 0° with respect to the shell axis. Calculations were also made to determine if there would be a significant change in the measured threshold foil activities if the detector were inadvertently positioned "upside down" (beam incident at 180°) during an experiment. The difference between the 0° and 180° activities was not sufficient to distinguish which end of the detector was oriented toward the beam. (auth)

2210 (STU-69-198/U-126) DEVELOPMENT OF COMPUTER-BASED SYSTEMS USED FOR NUCLEAR MEASUREMENT. Bjoerkman, J.; Sjoelin, P. G. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Jun 1971. 12p. (In Swedish). Dep. NTIS (U. S. Sales Only).

The use of on-line computers for nuclear measurements is described. Special attention is given to the use of γ-radiation detectors of the Ge(Li)-type as the information source. A survey of the market for minicomputers is made. The different possibilities for transmission of the analog signal from the detector to the digital storage in the computer memory are described. The program for the computer includes routines for showing an arbitrary part of the spectrum on a memory oscilloscope. Communication between operator and computer is facilitated with a so-called joystick. A manual for handling the system is given. (Sweden)

2211 (UCRL-20690) PURIFICATION SYSTEM FOR THE REMOVAL OF ELECTRONEGATIVE IMPURITIES FROM NOBLE GASES FOR NOBLE-LIQUID NUCLEAR-PARTICLE DETECTORS. Zaklad, Haim (California Univ., Berkeley. Lawrence Radiation Lab.). Apr 1971. Contract W-7405-eng-48. 80p. Dep. NTIS. Thesis.

A novel purification system is designed for the removal of O_2 and N_2 to the level of ppB in noble gases. A model for the reaction is proposed: $dc/dt = -kc^n$, where c is the concentration. The order of the reaction, n, was found to be 1.63 ± 0.16 for O_2 and 1.88 ± 0.25 for N_2. For argon the calcium purifier was sufficient to provide clean liquid, giving a maximum pulse height of 5.75×10^{-15} coulombs due to 1-MeV γ's from a ^{65}Zn source at an average field of 0.5 kV/cm. The probability of electron capture in argon by an oxygen molecule is 26 ± 5% per mm of drift per ppM O_2. In xenon some other unidentified electron-capture substance was present. The purification problem of xenon is solved by a low-temperature reaction on a copper catalyst and surface adsorption by using a molecular sieve column. (auth)

2212 (UCRL-73222) METAL-OXIDE-SEMICONDUCTOR X-RAY DETECTORS. Ciarlo, D. R.; Kalibjian, R.; Mayeda, K.; Boster, T. A. (California Univ., Livermore. Lawrence Livermore Lab.). 8 Oct 1971. 16p. (CONF-711111-9). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

Metal-oxide-semiconductor (MOS) devices have been used for detecting low-energy (2 to 20 keV) x rays for incident fluences of 10^{-4} to 10^{-1} cal/cm^2 (or dosage in the device of 10^3 to 10^6 rads) in a bent-crystal spectrometer application. An attractive feature of the detector is that the three functions of (1) detection, (2) memory, and (3) readout are integrated into one semiconductor chip. (auth)

2213 (UCRL-73505) SENSITIVITY PROBLEMS IN BIOLOGICAL AND ENVIRONMENTAL COUNTING. Armantrout, G. A.; Bradley, A. E.; Phelps, P. L. (California Univ., Livermore. Lawrence Radiation Lab.). Oct 1971. 25p. (CONF-711111-6). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

The general problem of sensitivity of Ge(Li) detectors for environmental counting is investigated. Analysis of biological and environmental samples differs from other physics applications in the need for very high sensitivity. A number of factors, including efficiency, geometry, resolution, and an interrelation of these, all affect sensitivity. An analysis, based on both experimental data and computations, indicates that in the range of equal detector volumes <40 cm^3, planar detectors are to be preferred over coaxial detectors due to their much better ability to quantitate data at energies below 500 keV without loss of performance at higher energies. For equal detector volumes in excess of 40 cm^3, coaxial detectors may be preferred for high energy use due to their better resolution, but performance at lower energies will still favor the planar detectors. (auth)

2214 CORRECTIONS OF THE FINITE SOLID ANGLE OF THE DETECTOR FOR THE γ-γ ANGULAR CORRELATION FUNCTION. Makaryunene, E. K. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys; 10: No. 6, 979-84(1970). (In Russian).

The corrections of the finite solid angle of the detector for the γ-γ angular correlation function are calculated for the 30 × 20 and 40 × 40 mm, NaI(Tl) crystals at γ-ray energies from 10 to 500 keV. (auth)

2215 IMPROVED ENERGY RESOLUTION WITH X RAY GAS DETECTORS. Policarpo, A. J. P. L.; Alves, M. A. F.; Carvalho, M. J. T.; Da Rocha, M. A. G. (Univ., Coimbra). N Instrum. Methods; 96: No. 3, 487-9(1971).

Detection of the light pulses from a xenon counter gives a resolution of 11.2% for 5.9 keV. This value can be further improved. (auth)

2216 SOLID ANGLE SUBTENDED BY A RECTANGULAR SLIT. Gotoh, H.; Yagi, H. (Japan Atomic Energy Research Inst. Tokai). Nucl. Instrum. Methods; 96: No. 3, 485-6(1971).

A solid angle subtended by a rectangular slit with an arbitrary thickness at an arbitrary point is represented by inverse trigonometric functions. (auth)

2217 ROCKET-BORNE CELESTIAL X-RAY PROPORTIONAL COUNTER SYSTEM. Burginyon, G. A.; Cornell, C. M.; Hill, R. W.; Iantuono, A. (Univ. of California, Livermore). Nucl. Instrum. Methods; 96: No. 3, 461-8(1971).

Characteristics of a new sensitive broad-range thin-window gas-flow proportional counter system, designed primarily for the detection of low energy X rays in rocket-borne experiments, are presented. A space conserving, two-gas, stacked concept is utilized. The system consists of a methane-filled front counter on top of an argon-filled back counter. A single eggcrate, charged vane collimator with a voltage on alternate vanes to eliminate background from cosmic electrons defines entry into both counters. To facilitate instrument calibration, a portable characteristic X-ray emitter for energies between 0.2 and 10 keV was developed. Some comments on its operation and performance are included. (auth)

2218 PROPORTIONAL COUNTER WINDOW FILTER FOR THE PREFERENTIAL DETECTION OF BORON-K X RAYS. Cairns, J. A.; Holloway, D. F. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 96: No. 3, 469-70(1971).

A filter, incorporated into a proportional counter window, allows the preferential transmission of boron-K X-rays, and substantially excludes interfering X rays of similar energy. (auth)

2219 HIGH EFFICIENCY PROTON POLARIMETER WITH SILICON DETECTOR ANALYSER. Frois, B. (Univ. Laval, Quebec) Birchall, J.; Lamontagne, R.; Roy, R.; Slobodrian, R. J. Nucl. Instrum. Methods; 96: No. 3, 431-6(1971).

A description of the polarimeter and its performance is given. It surpasses all other polarimeters in efficiency at comparable energy resolutions for protons of energies greater than 20 MeV. The scattering yield Y is 3×10^{-3} at 29 MeV with an analyzing power P of −0.3, giving a figure of merit $\langle PY^{\frac{1}{2}} \rangle$ of 1.6×10^{-2}. (auth)

2220 POLARIMETER CONSTRUCTED WITH TWO Si(Li) DETECTORS. Ljubicic, A.; Logan, B. A. (Univ. of Ottawa). Nucl. Instrum. Methods; 96: No. 3, 441-5(1971).

A gamma-ray polarimeter has been constructed using two Si(Li) detectors. The polarization sensitivity is an order of magnitude

higher than that of a single Si(Li) detector of approximately the same physical dimensions. The detection efficiency of the polarimeter is much less than that of a single detector but the large increase in the polarization sensitivity is sufficient to allow the polarimeter to be superior to the single detector polarimeter. (auth)

2221 PULSE SHAPE DISCRIMINATION IN PROPORTIONAL COUNTERS: EXPERIMENTAL RESULTS WITH AN OPTIMISED ELECTRONIC SYSTEM. Harris, T. J.; Mathieson, E. (Univ. of Leicester, Eng.). Nucl. Instrum. Methods; 96: No. 3, 397-403(1971).

Experimental results obtained with a proportional counter pulse shape discrimination system are described. The system employed the optimum set of circuit time constants derived in a previous theoretical study. With only 5% loss in detection efficiency and using a normal coaxial counter, an overall background reduction in the energy range 2 to 12 keV of around 30 times has been achieved; the background reduction in a restricted range near 6 keV was around 100 times. The limitations of the method for background reduction with increasing X-ray energy, and the effects of diffusion, are discussed. (auth)

2222 INVESTIGATION OF THE PULSE RATE EFFECT ON THE EFFICIENCY OF NEON FLASH TUBES. Ferguson, H.; Rastin, B. C. (Univ. of Nottingham, Eng.). Nucl. Instrum. Methods; 96: No. 3, 405-8(1971).

Studies of the characteristics of neon flash tubes have shown that the efficiency of these devices depends upon the rate at which particles are accepted by the apparatus (pulse rate effect). This work represents an investigation of the possible causes of the pulse rate effect. Results are presented which show conclusively that the charge collected on the tube walls by the action of the pulsed electric field is slow to clear. This produces a clearing field which removes the electrons liberated by the triggering particle from the gas and hence reduces the probability of the tube flashing. Further, the suggestion that polarization of the glass could produce a similar clearing field is disproved by other experimental results. (auth)

2223 ANALYSIS OF DECAY CURVES IN THE FORM OF SUMS OF EXPONENTIALS. Wauquier, J. M.; Barthe, J.; Commanay, L.; Terrissol, M. (Univ. Paul Sabatier, Toulouse). Nucl. Instrum. Methods; 96: No. 3, 409-13(1971). (In French).

A method for analyzing decay-curves like a sum of real and imaginary exponential components is presented. The number of these components is not settled before the analysis. Results are given for curves including three exponential components 2, 3, 4, 5, 6 and 7 components are studied systematically with different steps and different start-times. The precision of the results is only restricted by experimental precision. (auth)

2224 MULTIWIRE CHAMBERS OPERATING IN THE GEIGER-MUELLER MODE; NEW SIMPLE METHOD OF PARTICLE LOCALIZATION. Charpak, G.; Sauli, F. (CERN, Geneva). Nucl. Instrum. Methods; 96: No. 3, 363-7(1971).

Standard multiwire proportional chambers have been successfully operated in the Geiger–Mueller mode using an argon-ethylbromide gas filling. Very large pulses of a standard shape can be obtained, which allow several simple electronic arrangements for the detection. It is also proposed to use the streamer propagation time along the anode wires to obtain, with suitable pick-up electrodes, the coordinates of the initial avalanche. Accuracies ranging from 4 to 10 mm (fwhm) have been measured with a 38×38 cm^2 chamber. (auth)

2225 BISMUTH DETECTOR FOR 14-MeV PULSED NEUTRONS. Herbaut, Y. (CEN, Grenoble, France). Nucl. Instrum. Methods; 96: No. 3, 369-72(1971). (In French).

^{209}Bi is neutron activated, giving 2.7 ms half life ^{208m}Bi. The threshold of the reaction is 7 MeV. A detector constituted by a photomultiplier and a plastic scintillator surrounded by a bismuth shield has been built. The associated electronics allows for the measurement of the bismuth activity. The counting is made between pulses. The time between pulses must exceed 70 ms. Sensitivity is approximately 10^{-1} pulse for 1 n cm^{-2}. (auth)

2226 PULSE HEIGHT DEFECT IN SILICON SURFACE BARRIER DETECTORS. Hansen, N. J. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 96: No. 3, 373-81(1971).

A simple model is proposed which can be used to explain the existence of the dead layer, or window, that has been observed on silicon surface barrier detectors. Particles that are stopped in silicon detectors create a dense plasma of holes and electrons along their trajectory, and the charge collection process cannot proceed until these carriers have diffused radially away from the plasma. The holes, having a reduced mobility in the thin p-type inversion layer on the surface of n-type base material, will diffuse away more slowly than will holes in the bulk or depletion region, and this mechanism will inhibit the charge collection process in the surface layer. If the bulk hole mobility is μ_b, and the surface hole mobility is μ_s, the collection of carriers from the thin p-type surface will be reduced by the fraction $(\mu_s/\mu_b)^2$, and if the thickness of the p-type layer is Z_p, the effective window thickness will be given by $(\mu_s/\mu_b)^2 Z_p$. It is seen that the results of such calculations agree favorably with the measurements reported by Forcinal, Seiffert and Coche. Making use of recent measurements of the stopping powers for bromine and iodine ions, it is possible to calculate the residual defect for fission fragments as measured by Wilkins, Fluss, Kaufman, Gross and Steinberg. (auth)

2227 DIRECT CURRENT AMPLIFIERS WITH A LINEAR CHANNEL AND A LOGARITHMIC CHANNEL (MACC 1140 TO TACC 1140 AND ACC 140 TYPES). Roquefort, H. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Instrum. Nucl.; No. 42, 45-8(Jan 1971). (In French).

Amplifiers designed for measuring very low direct currents (from 10^{-14} to 10^{-5}A) which vary slowly with time, are described. They can be used for α, β, γ and neutron radiation measurements in ionization chambers and for the determination of low activity radioisotopes. They have a high sensibility and a very good stability. (France)

2228 TIME CORRELATIONS IN THE DETECTION OF SUCCESSIVELY EMITTED PHOTONS. Kocher, Carl A. (Columbia Univ., New York). Ann. Phys. (N. Y.); 65: No. 1-2, 1-18(15 Jun 1971).

An analysis is given of the correlation in detection times of two successive radiations emitted spontaneously in a sequential decay. By a resolvent operator method, the time evolution of the coupled particle-field state is derived for a system consisting of a three-level atom coupled to the photon field. Photons A and B, emitted in the first and second stages of the cascade, are detected at distances r_A and r_B from the atom. When one of the photons is detected, the state vector for the system is assumed to be reduced, by projection onto the observed state. After this measurement, the system again evolves continuously, until the second photon is detected. The probability that a retarded time interval $\bar{T} = (t_B - r_B/c) - (t_A - r_A/c)$ will elapse between the detection of photon A, at time t_A, and the detection of photon B, at time t_B, is found to be proportional to $\exp(-\Gamma\bar{T})$ if $\bar{T} > 0$ and to be zero if $\bar{T} < 0$, where $1/\Gamma$ is the mean lifetime of the intermediate state. This result is consistent with a prequantum view of successive photon emission, but is obtained by a method which avoids the conceptual difficulties of a point-particle photon model. (auth)

2229 SPHERICAL PROPORTIONAL COUNTER FILLED WITH ^3He. Korolev, V. I.; Savinskii, A. K. (Inst. of Biophysics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 71-2(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 68-9(Jan-Feb 1971).

The construction of a spherical proportional counter 90 mm in diameter with a practically constant gas multiplication along the anode filament is described. For an optimal filament diameter (0.05 mm) the energy resolution of the "thermal" peak of the $^3He(n,p)T$ reaction (Q = 764 keV) turned out to be at worst 5%. (auth)

2230 UNIT FOR THE CONTINUOUS PUMPING OF GAS THROUGH A PROPORTIONAL COUNTER UNDER A VARIABLE PRESSURE. Braegadze, Yu. I.; Maslyaev, P. F. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 73-4(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 70-1(Jan-Feb 1971).

A device used to improve the operating stability of plastic proportional counters by means of the continuous replacement of the working gas in the counter at a stipulated pressure in the range from 0.5 torr to 2 atm and for constant monitoring of gas purity is described. (auth)

2231 SHAPE OF THE LINE OF A GAS SPHERICAL PROPORTIONAL NEUTRON COUNTER HAVING A FILLER CONTAINING HYDROGEN. Andreeva, L. S.; Korolev, V. I.; Savinskii, A. K.; Filyushkin, I. V. (Inst. of Biophysics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 75-7(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 71-3(Jan-Feb 1971).

Analytical formulas which allow the energy-release spectrum (the shape of the line) to be obtained in a spherical proportional counter containing hydrogen with allowance for a) the wall effect, and b) the resolving power of the detector in the neutron energy range 10^{-3} to 10 MeV are presented. Results are given of numeri-

cal calculations for a counter 90 mm in diameter which is filled with CH_4 up to a pressure of 1 atm. (auth)

2232 LIGHT COLLECTION IN SCINTILLATORS HAVING A LARGE VOLUME. Baranov, V. T.; Zhukov, V. S.; Samylov, S. V.; Sonin, I. V.; Skvortsov, E. A. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 78(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 74(Jan-Feb 1971).

A comparison is made between the influence of total internal reflection and that of diffuse reflection on light collection in scintillators having a large volume. The advantage of the first method is shown. (auth)

2233 INVESTIGATION OF THE PLATEAU MECHANISM OF SCINTILLATION COUNTERS USING THE METHOD OF DIFFERENTIAL SPECTRA. Kilbal'chich, G. A.; Tsirlin, Yu. A. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 79-81 (Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 75-7(Jan-Feb 1971).

Equations are derived for the differential counting rate as a function of the voltage across the photomultiplier for a fixed threshold and a fixed channel width. It is shown that such differential spectra provide the possibility of investigating the mechanism by which the plateau develops and the dependence of this mechanism on various factors. (auth)

2234 MEASUREMENT OF THE TIME OF FLIGHT AND COORDINATES IN A SCINTILLATION COUNTER 130 cm LONG. Astvatsaturov, R. G.; Kolpakov, I. F.; Smirnov, V. A.; Khatchaturyan, N. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 82-5(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 77-80(Jan-Feb 1971).

The accuracy of determining the coordinates from the time difference between the arrival of light signals on the cathodes of photomultipliers situated on the end faces of a long scintillation counter ($8 \times 8 \times 130$ cm) was investigated. The accuracy of determining the coordinates and time of flight of a charged particle was approximately ±1.7 cm and ±0.38 nsec. It is shown that the accuracy of the measurements depends on the geometry of the counter. (auth)

2235 HODOSCOPE BASED ON MINIATURE FEU-85 PHOTOELECTRON MULTIPLIERS. Bugorskii, A. P.; Borisov, A. A.; Nurushev, S. B. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 86-8(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 80-2(Jan-Feb 1971).

The construction of a hodoscope containing miniature FÉU-85 photomultipliers is described, and its characteristics are investigated. The possibility of creating a hodoscope having working-cell sizes of 3 mm for operation with beams of particles for loadings of several MHz is shown. (auth)

2236 INSTRUMENT CONTAINING A SET OF LOW-EFFICIENCY GEIGER COUNTERS FOR MEASURING THE LINEAR ENERGY TRANSFER SPECTRA OF GAMMA-NEUTRON RADIATION. Keirim-Markus, I. V.; Kushnerev, A. Ya.; Popov, V. I. (Inst. of Biophysics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 89-93(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 82-6(Jan-Feb 1971).

An assembly of tissue-equivalent low-efficiency Geiger counters for measuring the linear energy exchange spectra of γ-neutron radiation was developed. The construction, parameters and characteristics of the counters, the electronic extinction circuit, as well as a description of the measurement panel for operation with an assembly of six counters, are given. (auth)

2237 RAISING THE SENSITIVITY OF MEASURING THE DOSAGE POWER OF IONIZING RADIATION. Strakovskaya, R. Ya.; Shesterikov, V. A. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 94-6(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 86-8(Jan-Feb 1971).

A device for measuring the dosage power of γ radiation by the method of integrating pulses having a length proportional to the scintillation-detector signal is described. The error of the measurements in the energy range from 0.084 to 1.25 MeV does not exceed 10%. The sensitivity of the method described considerably exceeds the sensitivity of the current method of measuring the dosage power. (auth)

2238 LOW-NOISE PREAMPLIFIER FOR Ge(Li) RADIATION DETECTORS. Panitkin, Yu. G. (Inst. of Physics and Power, Obninsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 146-7(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 129-30(Jan-Feb 1971).

A preamplifier is described which is designed according to a cascode circuit with dynamic loading and is based on 6S15P tubes The noise characteristic is NPV (keV) = 1.2 + 0.5 C_{in} (pF). (auth)

2239 HANDBOOK OF FLUORESCENCE SPECTRA OF AROMATIC MOLECULES. SECOND EDITION. Berlman, Isadore B. New York; Academic Press, Inc. (1971). 484p. $19.00. (TID-25840).

This book outlines the fluorescence and absorption characteristics of more than 200 aromatic compounds. Besides the spectra themselves, data characteristic of the fluorescence process are listed, including decay time, quantum yield, statistical width, Stokes loss, and average wavelength. Special attention is paid to the popular organic scintillators and fluors used in liquid lasers. R_0, C_0, overlap integral data, oscillator strengths, natural fluorescence lifetimes, bibliographies, etc., are listed in the appendices. Name and formula indexes of the spectra are included. (D.L.C.)

2240 EFFICIENCY OF RECORDING LONGWAVE X RADIATION BY MEANS OF SCINTILLATORS. Al'perovich, V. R.; Grinberg, N. B.; Komyak, N. I.; Morgovskii, L. Ya.; Plachenov, B. T. (Central Design Bureau of X-Ray Equipment, Leningrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 275-7(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 232-4(Jan-Feb 1971).

The characteristics of the scintillator crystals NaI(Tl), CsI(Tl), CsI(Na), and CaI_2 which are used to detect longwave x radiation were investigated. It turned out that the phosphorescence associated with the presence of capture levels in the crystals is of essential significance in the range of low energies of the x radiation. The phosphorescence produces a one-electron peak in the amplitude spectrum of the scintillations. A strong overlap of this peak with the photopeak of SiK radiation (1.73 keV) was observed, which complicated the measurement of intensity and caused an apparent increase in the recording efficiency. In the CsI(Na) crystal a decrease of recording efficiency was noted for longwave x radiation when its energy decreased. The possible physical causes of this effect are discussed. (auth)

2241 UNIT FOR AUTOMATIC RECORDING OF CONVERSION-ELECTRON SPECTRA. Morozov, V. A.; Muminov, T. M.; Razov, V. I.; Stegailov, V. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 50-2(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 51-3(Jan-Feb 1971).

A unit for automatic recording of conversion-electron spectra, based on a magnetic β spectrometer and a multichannel pulse analyzer, is described. (auth)

2242 BEHAVIOR OF A NEUTRON COINCIDENCE COUNTER FOR THE ASSAY OF PLUTONIUM. Sher, Rudolph (Stanford Univ., Calif.); Weinstock, Eugene V.; Strain, Charles V. Trans. Amer. Nucl. Soc.; 14: No. 2, 486-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2243 ANALYSIS OF AUTOMATIC FISSION TRACK SCANNING DATA. Gold, Raymond; Cohn, Charles E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 500(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2244 USE OF CARBON TETRAFLUORIDE AS A SCINTILLATION SPECTROMETER. Pagano, Roberto; Wethington, John A. Jr. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc.; 14: No. 2, 515-16(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2245 RESPONSE OF SHIELDED 3- AND 5-mm SILICON DETECTORS TO MONOENERGETIC GAMMA RAYS. Reier, Melvin; Dore, Michael A. (California Inst. of Tech., Pasadena). Trans. Amer. Nucl. Soc.; 14: No. 2, 544(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2246 NEUTRON/GAMMA COUNTING RATIOS OF 300-μm SILICON DETECTORS FOR PuO_2 RADIATION. Taherzadeh, Mojtaba; Dore, Michael A. (California Inst. of Tech.. Pasadena) Trans. Amer. Nucl. Soc.; 14: No. 2, 544-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2247 EXPERIMENTAL EVALUATION OF THREE SPECIAL XE-PRIME NEUTRON DETECTOR SENSITIVITIES AT 60°R. Rowland, J. W. (Westinghouse Electric Corp., Pittsburgh); Burlas, T. C. Trans. Amer. Nucl. Soc.; 14: No. 2, 547-8(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2248 ACCUARATE DOSIMETRY OF LOW-ENERGY X RAYS. Lyons, Peter B.; Baran, James A. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 908(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2249 CALCULATIONS AND MEASUREMENTS TO ESTIMATE THE EFFECTIVE W FOR NEUTRON-PRODUCED IONS IN IONIZATION CHAMBERS. Leonard, B. E. (Nuclear Systems Associates, Inc., Bethesda, Md.); Boring, John W.; Devine, Robert T. Trans. Amer. Nucl. Soc.; 14: No. 2, 909-10(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2250 MONTE CARLO PREDICTION OF MINIATURE G-M TUBE RESPONSE. Anno, George H.; Jordan, Thomas M. (ART Research Inc., Los Angeles). Trans. Amer. Nucl. Soc.; 14: No. 2, 914(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2251 RADIAL DISTRIBUTION WIDTH OF VOLUME ENERGY TRANSFER IN 4- TO 25-MeV α-PARTICLE TRACKS IN NaCl MONOCRYSTALS. Vaisburd, D. I.; Vorob'ev, A. A.; Komov, A. I.; Melikyan, L. A. (Tomsk Polytechnical Inst., USSR). Izv. Akad. Nauk Arm. SSR, Fiz.; 6: No. 2, 129-34(1971). (In Russian).
The conditions are found for which the transformation of radiation-induced defects is used for the determinination of effective crosswise particle-track dimensions in rigid bodies. The restoration reaction for F_2-centers is found to be appropriate in a series of α bombardments of NaCl crystals. The experiments on the Tomsk cyclotron for the determination of the effective α-track radii gave the value of (155 ± 15) Å. The track radius as determined by this technique is shown to be the radial distribution width of volumetric energy transfer in α-particle tracks in NaCl on the 6.10^{19} eV/cm³ level. (auth)

2252 MEASUREMENT OF DISINTEGRATION RATES OF RADIOACTIVE NUCLIDES BY THE $4\pi-\beta-\gamma$-COINCIDENCE METHOD IN THE DAMW. Schoenfeld, E. (Fachabteilung Ionisierende Strahlung, Berlin). Isotopenpraxis; 7: No. 7, 262-7 (Jul 1971).
Construction, properties and measuring range of the DAMW 4π $\beta-\gamma$-coincidence measuring device are described. The equations and corrections necessary for evaluation of disintegration rates from 4π $\beta-\gamma$-coincidence measurements are discussed in detail. The detector system consists of a 4π β-gas-flow-counter of the pillbox type and two big NaI(Tl)-crystals in a lead shielding of ≧7 cm thickness. For extremely thin sources, β-counting detection probabilities of nearly 1 are obtained. The β-background is near 2 counts per second. The γ-counting detection probability, depending on γ-energy and discrimination level lies in the range 0.2 to 0.4. There are measurable disintegration rates from 100 to 10,000 s^{-1}. In case of the nuclide ^{60}Co near $N_0 \approx 4{,}000$ s^{-1} one can achieve a total error of ±0.1%. (auth)

2253 ENERGY RESOLUTION OF Si(Li) DRIFT DETECTORS FROM VEB RFT MESSELEKTRONIK DRESDEN. Schwerd, K. (VEB RFT Messelektronik, Dresden). Isotopenpraxis; 7: No. 7, 309-12(Jul 1971).
The system resolution is defined in terms of detector resolution and the electronic system resolution, and representative data are presented that indicate the energy resolution for α, β, and γ radiation. (W.H.K.)

2254 STAINLESS STEEL SUPPORT GRID FOR FLOW-PROPORTIONAL COUNTER WINDOWS. Priestley, E. F.; Phelan, H. K. (Royal Armament Research and Development Establishment, Fort Halstead, Eng.). Nucl. Instrum. Methods; 96: No. 2, 235-6(1971).
A method of making stainless steel supporting grids for counter windows is described. The grids have high strength and good transmission. (auth)

2255 CONSIDERATION OF THE ADVANTAGES OFFERED BY A NEW STAINLESS STEEL SUPPORT GRID IN A PROPORTIONAL COUNTER WINDOW ASSEMBLY. Cairns, J. A. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 96: No. 2, 237-8(1971).
How a recently developed stainless steel grid offers considerable advantages when used in a proportional counter to support a thin window is described. (auth)

2256 COMPARISON BETWEEN EXPERIMENTAL AND CALCULATED RISE TIME DIFFERENCES IN SILICON SURFACE BARRIER DETECTORS. Frank, K.; Emmerich, W.-D.; Hofmann, A.; Vogler, F. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods; 96: No. 2, 247-52(1971).
Particle discrimination with one silicon surface barrier detector was performed in order to get information about the dependence of the pulse rise time on the particle energy. Calculations using a simple model including excess voltage of the detector and recombination of the electrons at the back contact of the diode are in good agreement with the experimental results. Moreover, pulse rise times were calculated for particles impinging on the back contact of the detector. (auth)

2257 RESPONSE OF A GAMMA COMPENSATED IONIZATION CHAMBER TO NEUTRONS IN INTENSE TRANSIENT GAMMA-FIELDS. Fukuda, K.; Okabe, S. (Radiation Center of Osaka Prefecture, Japan). Nucl. Instrum. Methods; 96: No. 2, 253-7(1971).
The usefulness of the gamma compensated ionization chamber for the monitoring of neutrons produced by a linear electron accelerator is studied. Measurements of neutrons were made with the chamber in x-ray fields up to 4.5×10^4 R/h, at the position of the chamber. The instantaneous x-ray level during the burst was 2.0×10^8 R/h. The compensating voltage at which the output current from the chamber becomes zero depends mostly on the incident bremsstrahlung energy and slightly on the x-ray level. These tendencies are also studied in the continuous x-ray fields. Neutron yields measured by the chamber for various targets are presented as a function of the incident electron energy. (auth)

2258 IDENTIFICATION OF HEAVY IONS USING A TIME-OF-FLIGHT TECHNIQUE WITH VERY THIN SURFACE BARRIER DETECTORS. Pleyer, H.; Kohlmeyer, B.; Schneider, W. F. W.; Bock, R. (Univ., Marburg, Ger.). Nucl. Instrum. Methods; 96: No. 2, 263-7(1971).
Time-of-flight telescopes with surface barrier detectors have been used in separating heavy ions with different energies down to 0.4 MeV/ nucleon. Mass determination in the range A = 4–19 and for fission fragments has been performed by a correlated measurement of flight time and energy; in addition the information on nuclear charge was provided by the ΔE-signal. An overall time resolution of 100–400 ps fwhm was obtained with ultrathin 1.7–17 μm transmission detectors. (auth)

2259 REDUCTION OF THE BACKGROUND IN A NaI(Tl) SCINTILLATION SPECTROMETER BY THE USE OF GEIGER ANTICOINCIDENCE AND MASSIVE SHIELDING. Stenberg, A. (Univ. of Uppsala). Nucl. Instrum. Methods; 96: No. 2, 289-99 (1971).
The background of a NaI(Tl) detector 3″ long and 3″ in diameter was reduced from 84 to 55 cpm, totally above 200 keV, by adding a 6-cm-thick layer of boric acid, 1 mm of cadmium, and 5 cm of lead in the cavity of the used shield originally built up of a good 10 tons of lead, 160 kg of borated paraffin, and 45 Geiger counters as an anticoincidence screen. This reduction mainly refers to the decreased contributions from airborne activities and from the secondary cosmic radiation. The reduced and the remaining sources of the background are discussed. (auth)

2260 PULSE SHAPE DISCRIMINATOR FOR AN X-RAY PROPORTIONAL COUNTER AND ITS APPLICATION TO A COINCIDENCE EXPERIMENT. Isozumi, Y.; Isozumi, S. (Kyoto Univ.). Nucl. Instrum. Methods; 96: No. 2, 317-23(1971).
A pulse shape discrimination system has been developed for an x-ray proportional counter to reduce the background caused by high energy radiations, by the use of a modified time-to-pulse-height converter. Test measurements with argon filled counters have shown that the system is at least 90% effective in reducing the background in the energy range 6 to 15 keV, while more than 95% of all the x-ray signals can be accepted. Even in the 20 to 35 keV region, reasonably good results for the background reduction and the x-ray acceptance have also been obtained. The technique has been successfully applied to the coincidence experiment with two proportional counters in order to eliminate false coincidences due to unfavorable high energy radiations passing through both counters. (auth)

2261 TIMING WITH Si(Li) SEMICONDUCTOR DETECTORS. Bishop, R. J. (Kingston Polytechnic, Kingston upon Thames, Eng.). Nucl. Instrum. Methods; 96: No. 2, 331-2(1971).
Experimental results are reported of the time resolution obtainable from a pair of Si(Li) semiconductor detectors operated in coincidence. (auth)

2262 NEW PULSE DIVIDING CIRCUIT AND ITS APPLICATION TO A POSITION SENSITIVE $^{10}BF_3$ PROPORTIONAL COUNTER. Westphal, G. P.; Pirker, H.; Fleck, C. M. (Oesterreichi-

sche Hochschule, Vienna). Nucl. Instrum. Methods; 96: No. 2, 333-9(1971).

A circuit is described which performs division of coincident pulses by means of a four quadrant multiplier incorporated in the feedback loop of a fast operational amplifier. Both the multiplier and the operational amplifier are monolithic IC's, which results in a simple construction of high accuracy, good thermal stability and high computing speed (110 kHz max.). A locus sensitive neutron detecting system built around the divider and a $^{10}BF_3$ proportional counter with resistive wire anode (60 cm length, 1 atm filling pressure, 600 Ω wire resistance) showed a typical resolution of 0.60 cm fwhm, measured with a collimated beam of thermal neutrons of width 1 mm. Electronic resolution simulated with an Hg-pulser was found to be 1.2 mm fwhm, which corresponds to a dividing accuracy of 0.2% full scale over a dynamic range of 1:15. (auth)

2263 AUTOMATIC CORRECTION FOR DECAY TIME IN MULTIPLE SAMPLE COUNTING. Rothem, T.; Gazit, Y. (Soreq Nuclear Research Centre, Yavne, Israel). Nucl. Instrum. Methods; 96: No. 2, 355-6(1971).

The decay of the activity of samples is corrected by lengthening the counting time in the appropriate ratio by a preset count from a sample having an identical decay rate. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 3503.

2264 (AERE-M-2455) ARCHIVE: A PROGRAM FOR STORING GAMMA SPECTRA ON MAGNETIC TAPE. Bullock, R. J.; Large, N. R. (Atomic Energy Research Establishment, Harwell (England)). Aug 1971. 5p. Dep. NTIS (U. S. Sales Only). UK 9.

ARCHIVE is a short program which reads gamma spectrometric data from paper or magnetic tape produced by various types of multichannel analysers and stores this information in an easily accessible form on magnetic tape. (auth)

2265 (ARH-SA-101) ANTICOINCIDENCE GUARDED, Ge(Li) DETECTOR FOR ENVIRONMENTAL LEVEL GAMMA ENERGY ANALYSIS. Zimmer, William H. (Atlantic Richfield Hanford Co., Richland, Wash.). Sep 1971. Contract AT(45-1)-2130. 11p. (CONF-711111-8). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

The environmental level gamma energy system developed at Atlantic Richfield Hanford Company laboratories consists of a single, large volume Ge(Li) detector with an NaI(Tl) anticoincidence guard, all operating in a laminar flow "Clean Room." A peak height-to-Compton edge ratio of better than 250:1, together with a reducing background, enables analysis of sample volumes from point sources to 700 cc. (auth)

2266 (BNWL-1594) INSTALLATION AND TESTING OF A SPENT FUEL AGE MONITOR AT NPD. Vaughn, A. D.; Christensen, D. E. (Battelle Pacific Northwest Labs., Richland, Wash.). Jul 1971. Contract AT(45-1)-1830. 40p. Dep. NTIS.

A spent-fuel-age monitor was installed in the spent fuel bay at the NPD Reactor, Rolphton, Ontario, Canada, for the purpose of determining cooling time of NPD irradiated fuel assemblies from gamma-ray measurements. The operation of the monitor is a safeguards experiment planned by the Joint Canada/USA Working Group on Safeguards Instrumentation as part of the Canada/USA Tamper Resistant Unattended Safeguards Techniques Program. The details of shipping, installation, and calibration and the initial testing results are presented. A significant result of the calibration measurements was that an operator acquainted with the decay characteristics of fission-product gamma-ray spectra estimated the cooling time with fair accuracy by visual inspection of the spectra. The initial testing results indicated that the cooling-time measurements can be obtained with the same techniques demonstrated during the cooling-time measurements of KE Reactor fuels and as reported in BNWL-1575. (auth)

2267 (JAERI-Memo-4560) MEASUREMENTS OF NONLINEARITY AND DETECTION EFFICIENCY OF A Ge(Li) SPECTROMETER. Tojo, Takao; Kondo, Makoto; Shiraishi, Tadao; Sezaki, Katsuji; Shoji, Isao (Japan Atomic Energy Research Inst., Tokyo). Aug 1971. 34p. (In Japanese). Dep. NTIS (U. S. Sales Only).

For the precise measurement of gamma-ray energies and the assay of radioactive nuclides by means of gamma-ray spectrometry, the differential nonlinearity of a Ge(Li) spectrometer with a 2048-channel analyzer and the absolute full-energy peak efficiency of the Ge(Li) detector were determined. In the measurement of the nonlinearity of a standard amplifier–analyzer system, two methods were used. One is the so-called gamma-ray method, using the gamma-rays of 38 different energies emitted from 12 nuclides, up to 3548 keV of ^{56}Co; and other is the mercury-relay pulser method. The nonlinearity of other spectrometer systems, in which only the standard-system linear amplifier was replaced by other amplifiers of 3 different types, and also that of the analyzer were measured by the pulser method. The results are shown as the deviations from linearity obtained by linear fitting of the data. In all the measurements, the nonlinearities were less than 0.1 percent. Absolute full-energy peak efficiencies were determined for the different gamma-ray energies, with the source distance of 5 cm, by using the same gamma-ray sources as for nonlinearity measurements. The absolute full-energy peak efficiency of 2.3×10^{-4} was obtained for the 1332.48-keV gamma ray of ^{60}Co. These results are shown together with the relative full-energy peak efficiencies normalized to the gamma-rays of 1332.48 keV. "The gamma-ray energies of useful sources for the energy calibration of a Ge(Li) spectrometer" are listed in the Appendix. (auth) (Japan)

2268 (JINR-P1-6071) DETERMINATION OF THE INFORMATION REGION OF THE SPECTRUM IN ANALYSING THE EXPERIMENTAL DATA BY THE FOURIER METHOD. Dubovik, V. M.; Markovski, B. L.; Sorko, L. M.; Strizh, T. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1971. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

The method is developed on the basis of the fast Fourier algorithm, allowing one to obtain in the on-line regime qualitative and quantitative information on the experimental histogram structure. The signal/noise separation is statistically based. (auth)

2269 (JINR-P13-6053) NEUTRON SPECTROMETER ON THE STILBENE CRYSTAL. Voitkovska, I.; Evseev, V. S.; Kozlovski, T.; Roganov, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 30p. (In Russian). Dep. NTIS (U. S. Sales Only).

The neutron spectrometer for 2 to 15 MeV neutrons on the 30 mm diameter and 20 mm thick stilbene crystal base with recoil proton detection and pulse-shape proton-electron discrimination is described. For neutron spectra calculations the method of differentiation with smoothing of proton recoil spectra is used. The problems of the application of the method are discussed, and the results of the main spectrometer parameter measurements are given. The spectrometer described has been made at the Laboratory of Nuclear Problems of the Joint Institute for Nuclear Research and used for measuring the spectra of neutrons from the nuclear mu-capture reaction. (auth)

2270 (JUL-774-ZE-FF) COMPUTER CONTROLLED TRIPLE AXIS NEUTRON SPECTROMETER WITH CAMAC INSTRUMENTATION. Zwoll, K. (Kernforschungsanlage, Juelich (West Germany). Zentrallabor fuer Elektronik); Schmidt, H. H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerperforschung); Mueller, K. D. (Kernforschungsanlage, Juelich (West Germany). Zentrallabor fuer Elektronik). Jun 1971. 64p. Dep. NTIS (U. S. Sales Only).

This report describes in detail the electric and electronic components of the Triple Axis Neutron Spectrometer operated by a PDP 8/I computer at the DIDO Reactor of the KFA Juelich. The communication between computer and experimental process is carried out via CAMAC instrumentation. Its flexibility and expandability, particularly in a laboratory environment, are demonstrated. (auth)

2271 (LUNP-7108) SUPPRESSION OF BACKSCATTERING IN BETA SPECTRA FROM SEMICONDUCTOR DETECTOR WITH AN ANTICOINCIDENCE SYSTEM. Petersson, Lennart (Lund Univ. (Sweden). Dept. of Physics). Jun 1971. 74p. Dep. NTIS (U. S. Sales Only).

A spectrometer for measuring β-spectra from a semiconductor detector is described. The main purpose has been to make the low energy distortion as small as possible and to catch as large a part of the backscattered radiation as possible with a second detector. The source-detector geometry used allows the γ-radiation to be completely eliminated with an absorption method. The spectrometer is tested by measuring the β-spectra from sources of ^{207}B; B^7Cs and ^{59}Fe. A comparison is made with theoretical β-spectra. The distortion of continuous β-spectra is reduced, which means that the corresponding Fermi–Curie plots give more correct maximum energies. (Sweden)

2272 (SC-RR-710453) PROTON-RECOIL SPECTROMETER FOR NEUTRON SPECTRUM MEASUREMENTS IN THE SANDIA PULSED REACTOR-II FACILITY. Powell, J. E.; Matthews, J. W. (Sandia Labs., Albuquerque, N. Mex.). Sep 1971. 186p. Dep. NTIS.

A proton-recoil fast neutron spectrometer capable of measurements over the energy range of 0.5 keV to 3.0 MeV has been developed for neutron spectrum studies in the SPR-II facility. Gas proportional counters were used as detectors and pulse shape discrimination techniques combined with two-parameter analysis were used to eliminate gamma ray background. A computer-based two-parameter analyzer was developed for these experiments and was interfaced to the Area V DADS to provide on-line data processing during the measurements. Spectra were measured in the glory hole, just outside the core, at several positions in the reactor room and in the beam hole facility with a resolution of 12% FWHM over most of the energy range. The data indicated that the neutron spectrum in the glory hole was substantially different from that out in the reactor room due to the influence of room return neutrons. Silicon damage and plutonium fission densities were calculated to demonstrate the significance of these results. Comparisons were made with fission couple spectrum measurements previously made in SPR-II. (auth)

2273 NOVEL ALGORITHM TO CALCULATE THE MEAN AND THE VARIANCE OF THE DISTRIBUTION IN EQUAL CLASSES FOR EXAMPLE THE RECORDINGS FROM A MULTICHANNEL ANALYZER. Vergnes, F. (CNRS, Nancy). Nucl. Instrum. Methods; 96: No. 3, 421-4(1971). (In French).

On integrating by parts the relation defining the first moment of a limited distribution, a simple relation is found between the mean and the integral of the repartition function. A second integration by parts, taking into account the preceding relation, allows the calculation of the variance from the two successive integrals of the repartition function. In the light of these analytical results, a simple algorithm is suggested that allows the calculation of the mean and the variance of the sample distributed in equal classes, by successive summations of the contents of these classes. The corresponding arithmetic identities are demonstrated and the results compared with those of the continuous case. The bounds of integration or summation can be selected arbitrarily beyond the maximal value of the stochastic variable. Using this algorithm, the number of operations for this calculation is considerably reduced. It is especially useful if only poor computing means are available: for example a simple adding machine. It is currently used for treating histograms recorded on a multi-channel analyzer which has an incorporated summation device. (auth)

2274 APPLICATION OF FOURIER ANALYSIS TECHNIQUES FOR THE INTERPRETATION OF PERTURBED ANGULAR CORRELATION. Forker, M.; Rogers, J. D. (Univ. Federal do Rio Grande do Sul, Porto Alegre, Brazil). Nucl. Instrum. Methods; 96: No. 3, 453-9(1971).

Fourier analysis is applied to the study of perturbed angular correlation time spectra. The effects of a finite measuring interval, discrete measuring points, statistical fluctuations, and nuclear relaxation on the Fourier spectra are shown using simulated time spectra. The effects of finite time resolution on the time spectra are reviewed and a method for partially removing them using Fourier techniques is presented. (auth)

2275 FAST NEUTRON SPECTROMETER USING A RECOIL PROTON PROPORTIONAL COUNTER WITH CURRENT AMPLIFICATION. Jeandidier, C. (CEN de Cadarache, Saint-Paul-les-Durance, France); Leridon, A.; Prieur-Drevon, M.; Moroni, M.; Rogerieux, M. Bull. Instrum. Nucl.; No. 43, 39-40(Mar 1971). (In French).

A measurement unit for in-pile fast neutron spectrometry between 10 keV and 1.4 MeV is presented. It can be used in fast Pu multiplying media and in subcritical assemblies with a multiplication factor up to 0.99. (France)

2276 NUCLEAR SPECTROMETRY UNIT CONNECTED TO A COMPUTER. Sarquiz, M. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Instrum. Nucl.; No. 43, 34-6(Mar 1971). (In French).

A system which gives the energy spectrum of a γ active substance in tabular or graphic form, enabling quantitative analysis to be performed, is presented. The four essential units of the system are briefly described including detection and analog processing of the signal, digital encoding and acquisition of the uncorrected data, storage and processing, and control and display of the data. Such systems illustrate the possibility of using standard units connected to a computer by a CAMAC system. (France)

2277 AUTOMATIC DEMAGNETIZATION OF THE MAGNETS OF BETA-SPECTROMETERS. Babenkov, M. I.; Basin, L. A. (Inst. of Nuclear Physics, Alma-Ata, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 253-4(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 214-15(Jan-Feb 1971).

An automatic device for preparing the magnets of a β-spectrometer for operation by demagnetizing them along a twisting hysteresis loop is described. The remanent field after demagnetization does not exceed 0.05 ± 0.01 Oe. (auth)

2278 SEPARATION OF THE NOISE FROM A PULSE GENERATOR AND A SPECTROMETRIC PREAMPLIFIER. Selyutin, V. P.; Il'in, A. A. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 148-9(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 130-2(Jan-Feb 1971).

A method for measuring the noise from the monitoring pulse generator and preamplifier directly on a spectrometer without using additional instruments is described. In this process two or more spectra are taken from the investigated pulse generator for different amplifier gains, and then the noise of the pulse generator and preamplifier are found from these spectra by calculation. Results are given for noise measurements on two monitoring pulse generators used in α-spectrometers with a semiconductor detector. (auth)

2279 LOW-ENERGY POSITRON SPECTROMETRY. Schikorr, M. W.; Lohnert, G. H.; Schneider, R. T. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc.; 14: No. 2, 501-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2280 GAMMA-RAY DOSIMETRY FOR THE NATURAL ENVIRONMENT. Gold, Raymond (Argonne National Lab., Ill.); Strash, Alfred M. Trans. Amer. Nucl. Soc.; 14: No. 2, 502-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2281 CONTINUOUS GAMMA-RAY SPECTROSCOPY WITH LIQUID SCINTILLATORS. Strash, Alfred M. (Macalester Coll., St. Paul); Gold, Raymond; Oltman, Billie G. Trans. Amer. Nucl. Soc.; 14: No. 2, 894-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2282 IN-CORE NEUTRON SPECTRUM MEASUREMENTS USING LIQUID SCINTILLATION SPECTROMETRY. Coolbaugh, M. J.; Meyer, Walter; Faw, R. E. (Kansas State Univ., Manhattan). Trans. Amer. Nucl. Soc.; 14: No. 2, 911-12(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2283 DEVELOPMENT OF A TAC SPECTROMETER SYSTEM WITH OFF-LINE GAMMA-RAY DISCRIMINATION. Seck, R. E.; Meyer, Walter; Krick, M. S. (Kansas State Univ., Manhattan). Trans. Amer. Nucl. Soc.; 14: No. 2, 912-14(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2284 MONTE CARLO CALCULATION OF SODIUM IODIDE SCINTILLATION DETECTOR RESPONSE FUNCTION. O'Dell, A. A. (EG and G, Inc., Goleta, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 914-15(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2285 TIME-OF-FLIGHT SPECTROMETER ATTACHED TO A HIGH-FREQUENCY ACCELERATOR. Aleksanyan, A. S.; Bagdasaryan, L. S.; Bekker, B. I.; Vinnitskii, O. M.; Pikhtelev, R. N. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Fiz.; 6: No. 2, 142-5(1971). (In Russian).

A fast spectrometer for the determination of the time of flight of neutral particles generated by the pulsed beam of an accelerator is described. (auth)

2286 RELATIVE INTENSITY CALIBRATION OF A Ge(Li) GAMMA-RAY SPECTROMETER. Jardine, L. J. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 96: No. 2, 259-62(1971).

Portions of the gamma-ray spectra of ^{182}Ta and ^{180m}Hf have been remeasured with a Ge(Li) spectrometer system to determine accurate relative intensities. For ^{182}Ta the eleven strongest transitions in the energy range of 100 to 1300 keV were measured. The $I_\gamma(443)/I_\gamma(501)$ relative gamma-ray branch in ^{180m}Hf was remeasured to be 5.70 ± 0.15. The intensity values derived from these measurements are recommended for use with an IAEA standard intensity set in the calibration of relative photopeak efficiencies for Ge(Li) detectors. An overall accuracy of ±4% for the relative intensity calibration over the energy range of 100 to 1300 keV can be expected and ±3% for the 500 to 2800 keV energy range. (auth)

2287 NORMAL AND RANDOM PULSE GENERATORS FOR THE CORRECTION OF DEAD-TIME LOSSES IN NUCLEAR SPEC-

TROMETRY. Wiernik, M. (Soreq Nuclear Research Center, Yavne, Israel). Nucl. Instrum. Methods; 96: No. 2, 325-9(1971).

Severe systematic errors can be encountered when using a normal pulse generator for the correction of dead-time losses in nuclear spectrometry. These errors can be avoided if the ratio between the theoretical dead-time produced by the pulser and that produced by the detector signals is kept below 0.1, and a correction factor can be applied if this ratio is increased in order to improve the precision of the measurements. The use of a so-called "random" pulse generator, which does not cause these systematic errors, is recommended. (auth)

High Energy Physics Instrumentation

2288 (BMBW-FBK-71-11) AUTOMATIC MEASUREMENT OF BUBBLE-CHAMBER FILMS WITH COUPLED DIGITAL COMPUTERS. Nagel, H.-H. (Bonn Univ. (West Germany). Physikalisches Institut). Sep 1971. 214p. (In German). Dep. NTIS (U. S. Sales Only).

Analysis of data handling problems for the automatic measurement of bubble chamber film suggests the coupling of two digital computers. All operations necessary for the control of the digitizing apparatus (Hough-Powell-Device-HPD) and for extracting measurements of particle tracks are combined into one program executed by a large central computer. The real time constraints posed by the HPD are satisfied by a direct connection between the central computer and a peripheral computer integrated into the HPD control electronic. The distribution of tasks between central and peripheral computer as well as between electronics and programs is described. (auth)

2289 (CERN-Trans-71-25) ELECTRIC DISCHARGE OF GAS BUBBLES IN LIQUIDS. Pisarev, A. F.; Selivanov, G. I.; Balandin, M. P.; Lytkin, L. K. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by R. Luther (CERN, Geneva, Switzerland), from report JINR-P13-5277. 11p. Dep. NTIS (U. S. Sales Only).

A description is given of a method for calculating fields for the discharge of bubbles by steady, pulsed, and high-frequency electric fields. The calculation is based on the main criteria and some of the experimental dependences of the electric breakdown of a gas in small gaps. The methods are investigated by using specific examples of the electric discharge of bubbles in such liquids as helium, hydrogen, xenon, and neon. These liquids are widely used in bubble chambers and at the present time it is particularly interesting to examine the discharge of bubbles in them. The technique described is equally suitable for any other liquids. (W.H.K.)

2290 (CERN-Trans-71-27) SCINTILLATION HODOSCOPE WITH LIGHT CODING. Burgorskii, A. P.; Borisov, A. A.; Derevshchikov, A. A.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by R. Luther (CERN, Geneva, Switzerland), from report IFVE-70-50. 13p. Dep. NTIS (U. S. Sales Only).

The design and operation of a hodoscope composed of an optically coded array of scintillation detectors are briefly described. (W.H.K.)

2291 (EFI-ME-5(70)) STUDY ON THE WIDE GAP SPARK CHAMBER WITH A LOW SUPPLY TENSION. Avakian, K. M.; Ajvazian, R. B.; Matevosian, E. M.; Krishtchyan, V. M. (Akademiya Nauk Armyanskoi SSR, Erevan. Institut Fiziki). 1970. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

A wide gap spark chamber with two gaps 15 cm each with an electric field of 1.5 kV/cm was studied. It was found that in such a chamber the spark follows the track of a particle with high accuracy and has high brightness which permits the use of a small aperture when making photographs. (auth)

2292 (IFVE-SEF-70-88) SYSTEM OF A MULTIDIMENSIONAL PULSE-HEIGHT ANALYSIS FOR REGISTRATION OF PARTICLES WITH A FRACTIONAL CHARGE. Antipov, Yu. M.; Yetch, F. A.; Zaytzev, A. M.; Landsberg, L. G.; Lebedev, A. A.; Morozov, A. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

A description of the devices for multidimensional pulse-height and time analysis is presented. These devices were applied in the experiment on the search for particles with a fractional charge at the 70 GeV IHEP accelerator. (auth)

2293 (IFVE-SVM-70-76) FUNCTIONAL PRINCIPLES OF A MODULATING ANALYZER FOR BUBBLE CHAMBER PICTURES. Sokolov, S. N.; Utochkin, B. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

Functional principles of a new device, called a modulating analyzer, for handling bubble chamber pictures are described. The device is used to determine the parameters of a particle trajectory in the bubble chamber by direct interposition of the track image on the trajectory projection model, measurements of coordinates of separate points (bubbles) being omitted. The block-diagram of the device and its peculiar units such as a modulating cathode ray tube and the channel that generates an "agreement" signal are given. The possible operational logics of the device is explained. (auth)

2294 (ITEF-793) THE "TREK" PROGRAM. Vladimirskii, V. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 96p. (In Russian). INIS.

The program "Trek" for the electronic computer "Razdan-3" is described as a portion of a program for treatment of photographs from spark chamber spectrometers in a magnetic field. The program computes the impulses of particles, and angle and matrix errors, using as the data source the points measured in the track in Cartesian coordinates. (tr-auth)

2295 (JINR-P13-5967) SYLPHON BELLOWS FROM FIBER GLASS AND THEIR CHARACTERISTICS. Kruglyakova, V. I.; Mal'kov, V. M.; Polakh, I.; Slepneva, L. V.; Filippov, A. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

The technology involved in the fabrication of fiber glass sylphon bellows for use in bubble chambers is described. A comparison is made of experimental and calculated values of stress in the jacket from the stretching force and the internal pressure, and the difference between the two sets of values (for some ranges of sylphon bellows) is caused chiefly by the non-ideality of mounting of the rim of the sylphon bellows to the flanges, and in part to the technology itself of the sylphon bellows. (tr-auth)

2296 (JINR-P13-6019) CHERENKOV PARTICLE COUNTER. Soroko, L. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The construction of the low-noise multiplex Cherenkov counter is described which has, in comparison with the traditional Cherenkov counters, rather favorable performances including low noise effect from photomultiplier and low physical background from the correlated knock-out-photoelectrons from the light-collecting system. The principle of operation of the multiplex Cherenkov counter is described. (auth)

2297 (JINR-P13-6037) VAPOR BUBBLE DYNAMICS IN HYDROGEN BUBBLE CHAMBERS. Tkachev, L. G.; Shestakov, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

Theoretical considerations of vapor bubble dynamics in a hydrogen bubble chamber are given. The system of equations takes into account the heat and mass exchange between a bubble and liquid. The vapor in the bubble is described with the real gas equation of state. Computer solutions are in agreement with the corresponding experiment. A set of temperature distributions in the surrounding liquid during the bubble chamber cycle is presented. The important role of the temperature distribution formed during the bubble growth is shown for the correct description of the bubble collapse. Some predictions are made for the bubble behavior in fast-cycling chambers. (auth)

2298 (LA-tr-71-77) TRACK CHAMBER WITH CHARGE MULTIPLICATION INSIDE THE FILM ELECTRODES. Nikanorov, V. I.; Pisarev, A. F.; Selivanov, G. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Translated by Helen Dahlby (Los Alamos Scientific Lab., N. Mex.), from report JINR-P13-5780. 12p. Dep. NTIS.

Charge multiplication, observed in porous dielectric and semiconductor films in the presence of an electric field, is considered from the point of view of construction of a coordinate chamber and counters for charged particle recording based on this effect. The variant of construction of a track chamber using the boundary luminescence of media is also considered. (auth)

2299 (LA-tr-71-78) NEW METHODS OF DETECTING PARTICLE TRACKS IN LIQUID AND SOLID MEDIA. Nikanorov, V. I.; Pisarev, A. F.; Selivanov, G. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Translated by Helen Dahlby (Los Alamos Scientific Lab., N. Mex.), from report JINR-P13-5782. 19p. Dep. NTIS.

The possibility of designing solid detectors containing thin wires frozen or polymerized in a medium is considered. Near these wires gas bubbles are created artificially where primary electrons, produced in the particle tracks, are multiplied. Discrete particle counters which are a combination of scintillating filaments and tunnel photodiodes or channel electron multipliers (CEM's) are also considered. Also, the possibility of using separate CEM's for fast particle detection is analyzed. (auth)

2300 (LAL–1253) DEVELOPMENT AND PERFORMANCE OF CYLINDRICAL SPARK CHAMBERS WITH THIN WALLS USED ON THE ORSAY ELECTRON–POSITRON STORAGE RING. Cosme, G.; Jean-Marie, B.; Jullian, S.; Lefrancois, J. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Jun 1971. 26p. (In French). Dep. NTIS (U. S. Sales Only).

The cylindrical spark chambers that have been used as detector for the storage ring ACO at Orsay are described. Each cylindrical modulus, of 7.5 mm gap and thickness 0.21 g/cm^2, consists of two walls of low-density foam material glued on each side to a sheet made from banding 50-μ aluminum and 130-μ mylar foils. By studying the gas and triggering system, very good multitrack efficiency was obtained without spurious sparks. In order to observe tracks in the two orthogonal directions, the high reflectivity of the aluminum on the inner walls of the gap was used. Details on the construction and performances are given. (auth)

2301 (NP–19026) PROJECT OF A Λ^0 MISSING MASS SPECTROMETER TO STUDY THE REACTION $\pi^- + p \rightarrow \Lambda^0 + NEUTRALS$. Note No. 304. Bruner, I.; Dore, U.; Guidoni, P.; Laakso, I.; Martellotti, G.; Marini, G.; Massa, F.; Piredda, G.; Pistilli, P. (Rome Univ. (Italy). Istituto di Fisica). 22 Jan 1971. 37p. Dep. NTIS (U. S. Sales Only).

A counter-spark chamber apparatus designed to investigate the neutral missing-mass (M^0) spectrum in the reaction $\pi^- + p \rightarrow \Lambda^0 + X^0$, via the detection and measurement of the Λ^0's produced with small 4-momentum transfer ($\Delta^2_{p\rightarrow\Lambda^0} < 1$ (GeV/c)^2) is described. The physical interest in the exploration of the M^0 spectrum below 1.8 GeV/c^2, at incident π^- momenta between ~5 and 10 GeV/c, is briefly outlined. Estimates for the foreseen X^0 mass resolution and the expected counting rates are also given. (auth)

2302 (UCRL–Trans–10558) RELATIVISTIC RISE OF IONIZATION IN GASEOUS TRACK DETECTORS. Merzon, G. I. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated for Univ. of California, Lawrence Livermore Lab., from Preprint No. 73. 13p. Dep. NTIS.

The Sternheimer formula for the specific energy losses of fast charged particles is shown to be incorrect in the description of the results of ionization measurements in Wilson cloud chambers and other track detectors containing gases of medium and high atomic number. A modification of this formula makes it possible to make the experimental data obtained by Kepler et al. for argon and helium + argon and helium + xenon mixtures consistent with theory. The conclusions of this work should be borne in mind in the planning of experiments in which particles with energies of ~10^3 GeV are to be identified by the relativistic rise in ionization in the gas. (auth)

2303 AUTOMATIC DIGITAL SYSTEM FOR ANALYZING BUBBLE CHAMBER PHOTOGRAPHS OR ANALOGS. Equer, Bernard; Guignard, Claude; Reboul, Guy; Volte, Albin (to Agence Nationale de Valorisation de la Recherche). French Patent 2,041,715. 5 Feb 1971. Filed 9 May 1969. (In French).

An automatic digital unit for analyzing bubble chamber photographs, or more generally, planar images consisting of discrete points or lines is described. The apparatus consists of a cathode ray tube, a light spot for scanning the photographs, a photomultiplier, a delay line system, and a means of determining the spot coordinates. The apparatus is based on the principle that pulses arising from the total or partial obscuring of the spot by a linear track, during the scanning of several lines, form a pulse sequence with a recurrent period depending upon the angle between the track and the scanning lines. The modulated light is received by a photomultiplier and the electrical pulses resulting are transferred to a system composed of several delay lines having delays equal to the respective delays presented by the signal due to the spot crossing the lines at a given angle. The output of the delay lines are connected to a threshold circuit and the spot coordinates are determined at the instances when an output signal occurs. (France)

2304 ILLUMINATION SYSTEM OF IMPROVED POWER AND RESOLUTION FOR THE HOUGH–POWELL DEVICE. Lawes, R. A. (Rutherford High Energy Lab., Chilton, Eng.); Welford, W. T. Nucl. Instrum. Methods; 96: No. 3, 383-6(1971).

An HPD illumination system is described which uses an argon laser and requires a minimum of modification to the existing optomechanical structure. A diffraction limited measuring spot of 3 μm diameter (at 50% intensity) is obtained at a power level of about 1 μW. Photon noise effects are reduced to negligible proportions for known applications of the machine, including the measurement of brightfield film from the new bubble chambers. (auth)

2305 VERSATILE HIGH RESOLUTION BEAM POSITION MONITOR. Cummings, U.; Leith, D. W. G. S.; Williams, H. H. (Stanford Univ., Calif.). Nucl. Instrum. Methods; 96: No. 3, 357-61(1971).

A new kind of Cherenkov beam position monitor is described. The counter, though relatively simple and inexpensive, has high sensitivity, introduces a minimal amount of multiple scattering, and is capable of high spatial resolution over a wide range of beam currents. Measurements of the position of the SLAC electron beam to an accuracy of $\pm\frac{1}{2}$ mm have been made for electron currents from 20 nA to 10 mA. (auth)

2306 POSSIBILITY OF USING A SUPER-ORTHICON METHOD OF INFORMATION READOUT FROM SPARK CHAMBERS. Gorokhov, V. P.; Petrakov, A. V. Izv. Akad. Nauk Arm. SSR, Fiz.; 6: No. 1, 64-7(1971). (In Russian).

Investigation results of some super-orthicon characteristics of the LI–17 which have been effected under microsecond light-up pulse operation conditions, for use in television automatic devices for information readout from spark chambers are reported. A comparison with vidicon characteristics is made. (auth)

2307 APPARATUS OF THE NBC TYPE AND THE PHYSICS RESULTS OBTAINED. Zichichi, A. (Istituto Nazionale di Fisica Nucleare, Bologna. Univ., Bologna). Ann. Phys. (N. Y.); 66: No. 2, 405 48(Aug 1971).

A nonbubble chamber (NBC) setup, especially designed to perform a series of experiments, is described. The setup consists of a neutron missing-mass spectrometer coupled with a system of large electromagnetic shower detectors. In spite of its large dimensions (the sensitive surface and volume are 2.16×10^4 cm^2 and 7.8×10^5 cm^3, respectively), the neutron spectrometer has a time resolution of ±0.70 nsec FWHM, with ~25% detection efficiency in the range (70 to 390 MeV) neutron kinetic energy. The time equalization between the various components of the neutron spectrometer was established to within ±0.1 nsec. At present this is the most powerful and the most accurate high-energy neutron detector. The electromagnetic shower detector is based on the principle of simultaneous measurements of the spatial development of the electromagnetic cascade and of its energy release. This is obtained with nine elements of lead foil–spark chamber–plastic scintillator, all sandwiched together. The sensitive surface and volume of the electromagnetic shower detector are 1.45×10^4 cm^2 and 7.2×10^5 cm^3, respectively. The setup described and the experimental results obtained show that it is possible, in the field of NBC physics, to reduce the cost and the time needed for an experiment provided that multipurpose NBC setups are used. (R.W.R.)

2308 MEASUREMENT OF THE ENERGY OF ELECTRONS FROM THE NUMBER OF SHOWER PARTICLES IN THE REGION OF THE SHOWER MAXIMUM. Dunaitsev, A. F.; Ivan'shin, Yu. I.; Kakauridze, D. B.; (and others) (Inst. of High-Energy Physics, Serpukhov, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 47-9(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 48-50(Jan-Feb 1971).

A new method of measuring the energies of electrons and γ quanta according to the number of shower particles in the region of the shower maxima was investigated experimentally. The measurements carried out on electron beams having energies of 5, 10, and 15 GeV demonstrated the possibility of measuring energy with an accuracy of up to ±13%. (auth)

2309 METHOD OF DETERMINING THE COORDINATES OF A SPARK FROM THE DEPTH OF THE SPARK CHAMBER. Korenchenko, S. M.; Nekrasov, K. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 53-4(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 54-5(Jan-Feb 1971).

A new method for determining the coordinates of a spark in a spark chamber along the axis perpendicular to the photographing plane is described. (auth)

2310 POSSIBILITIES IN PRINCIPLE OF IMPROVING THE TIME PROPERTIES OF A SPARK CHAMBER. Leksin, G. A.; Sokolov, V. K. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 55-7(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 55-7(Jan-Feb 1971).

A method is advanced for improving the time properties of a

spark chamber by introducing two control-grid electrodes into the spark gap. (auth)

2311 ELECTROMECHANICAL DRIVE FOR A MICROSCOPE TABLE. Zaika, N. D.; Kuz'michev, M. A. (Physical-Technical Inst., Kharkov). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 62-4(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 61-3(Jan-Feb 1971).

A network which solves the problem of decomposing a velocity vector into orthogonal components by digital automation methods is described. It allows an open-loop automatic control system without feedback to be created. The accuracy of such a system is determined by the number of digits in the direction transmitter and therefore by the amount of equipment. The foundation of the network is a linear discrete interpolator that converts a binary code into a unitary pulse train. The electromechanical drive allows the directional movement of thick-layer photoemulsions for measurement in a microscope. (auth)

2312 SEMIAUTOMATIC MICROSCOPE FOR GEOMETRIC MEASUREMENTS IN NUCLEAR PHOTOEMULSIONS. Zaika, N. D.; Kuz'michev, M. A.; Rutkevich, N. Ya. (Physical Technical Inst., Kharkov). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 65-6(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 63-4(Jan-Feb 1971).

A semiautomatic unit for geometric measurements of events recorded in thick-layer nuclear emulsions is described. A modernized MBI-8M microscope is equipped with a two-coordinate table having an electromechanical drive. The measurement of the tracks is accomplished in a three-dimensional Cartesian coordinate system using digital position transmitters. The information is punched out on tape in a form suitable for direct calculation on an electronic computer. A brief description is given of the basic sections, and the engineering characteristics of the unit are provided. (auth)

2313 GAS DIFFERENTIAL CHERENKOV COUNTER HAVING DISPERSION COMPENSATION. Bushnin, Yu. B.; Gorin, Yu. P.; Denisov, S. P.; (and others) (Inst. of High-Energy Physics, Serpukhov, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 67-70(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 65-7(Jan-Feb 1971).

A gas differential Cherenkov counter with compensation of the dispersion of Cherenkov radiation by a doublet of conical quartz prisms and a NaCl crystal is described. The characteristics of the counter were investigated on beams of particles from a 70 GeV accelerator at momenta of 40 to 60 GeV/c. The velocity resolution turned out to equal $1.5 \cdot 10^{-5}$, and the background level was $3 \cdot 10^{-6}$. (auth)

Radiation Dosimeters

Refer also to abstracts 1870, 2223, 2402, and 3067.

2314 (CEA-R-4229) READING OF RADIOLUMINESCENT DOSIMETERS. Chenault, Roger; Prigent, Raymond (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1971. 28p. (In French). Dep. NTIS (U. S. Sales Only).

This apparatus, especially designed for measurements on luminescence phenomena exhibited by LiF, can also be used with other radioluminescent materials (alumina, lithium borate). A feature is that low temperature luminous emission, which is a nuisance because of its instability, is eliminated; this is achieved by including a preheating region whose temperature and duration can be varied, which precedes the classical temperature rise while the measurements are made. A photomultiplier is included with an 800 to 1300 volt integrated transistorized e.h.t., which delivers between 10^{-9}A and 10^{-4}A according to the luminous intensity delivered by the dosimeter. The experimental results are delivered in an analog or digital form (automatic commutation of sensitivity ranges, possibility of printing out the results). Two principles of operation are simultaneously assured: either the production of a spectral curve (from the photomultiplier output current) and integration of this current (visual display on numeric device of the integrated value, which is stored in a memory, or the production of a spectral curve and measurement of the peak current value (displayed and stored in a memory). The spectral curve permits the fitting of a heating law during the adjustments; and a permanent control of the correct functioning of the apparatus during the measurements. The measurement dynamics correspond to a peak value between 10 and 100 rads and an integration between 10 mrad and 1000 rads. The optimum precision of the assembly is 5%. (auth)

2315 (CONF-710705-12) INTEGRATING TYPE SCINTILLATION BETA DETECTORS FOR RAPID MONITORING OF AQUEOUS MEDIA. Kazanskaya, V. A.; Petrusev, S. S.; Sokolov, A. D.; Fedorovskiy, Yu. P. [1970]. 12p. Dep. NTIS (U. S. Sales Only).

From International symposium on rapid methods for measuring radioactivity in the environment; Munich, Germany (5 Jul 1971).

The development of thermoluminescent and exoelectron radiation dosimeters for rapid measurements of the specific volumetric beta activity of aqueous media and integral measurements of the beta activity of streams is discussed. $CaSO_4$(Mn) was selected for rapid measurement of specific volumetric activity; and $CaSO_4$(Dy), for integral measurements. Threshold sensitivities for these dosimeters are given. (R.W.R.)

2316 (K-1821) NEW METHODS FOR INTERPRETING NEUTRON DATA OBTAINED FROM Y-12 NUCLEAR ACCIDENT DOSIMETER, ORGDP FILM BADGE, AND HURST THRESHOLD DETECTOR UNIT. Bailey, J. C. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 15 Oct 1971. Contract W-7405-eng-26. 46p. Dep. NTIS.

Improved methods have been developed for the interpretation of neutron data obtained from the Y-12 Type Nuclear Accident Dosimeter, the Union Carbide Corporation, Nuclear Division, film badge, and the Hurst threshold detector unit, all of which are in use at the Oak Ridge Gaseous Diffusion Plant. Basic experimental information on which these improved interpretation methods were based was obtained through the use of a new dosimeter developed at ORGDP. The data-interpretation methods were applied to dosimeter data obtained through the exposure of dosimetry units and phantoms, simulating human exposures, to radiation from the Health Physics Research Reactor at the Oak Ridge National Laboratory under four different shielding configurations, which provided widely different spectra. Neutron dose values determined with a Hurst absolute proportional counter served as the basis of comparison for all units. With a single exception involving a very heavily shielded configuration—a case which should be recognizable even in an accident situation—dose values derived from film badges on the phantoms facing the reactor were accurate to within 22%. These determinations included badges which were shielded from the reactor by the phantoms. All of the dosimeters yielded dose values which were biased low by about 25% for phantoms turned with a side toward the reactor—a result considered to be consistent with a lower effective dose for a side exposure due to the higher degree of self-shielding of the body for this position as compared to a front or back exposure. (auth)

2317 (NP-18948) METHOD OF THERMALLY STIMULATED EXOELECTRON EMISSION IN THE DOSIMETRY OF IONIZING RADIATION. Jimenez, Hector Ursulino Rueda (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). Apr 1971. 71p. (In Spanish). Dep. NTIS (U. S. Sales Only).

Thesis.

The thermally stimulated exoelectron emission method for the dosimetry of ionizing radiations is described and its development is discussed. The model explaining this phenomenon is considered in some detail. Experimental results obtained for calcium fluoride + graphite, two graphite samples, and lithium borate activated with Mg and graphite are reported. The exoelectron emission spectra caused by x rays and γ rays are given. (J.S.R.)

2318 APPLICATION OF RADIATION DAMAGE TO RADIATION DOSIMETRY. Yamaguchi, Masafumi; Nagai, Osamu (Nippon Telegraph and Telephone Public Corp., Tokai, Japan). Jap. J. Appl. Phys.; 10: No. 11, 1638(Nov 1971).

The variation of the reciprocal gain of n-p-n silicon transistors is studied as a function of electron and gamma dose for possible application to dosimetry. (W.H.K.)

2319 TLD MEASUREMENT OF GAMMA HEATING IN HEAVY ELEMENTS. Reilly, H. J.; Robinson, R. A.; Peters, L. E. Jr. (Plum Brook Station, Sandusky, Ohio). Trans. Amer. Nucl. Soc.; 14: No. 2, 910-11(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2320 HIGH-TEMPERATURE DOSIMETERS FOR NUCLEAR REACTORS. Mehta, K. K. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Trans. Amer. Nucl. Soc.; 14: No. 2, 911 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2321 DOSIMETRIC PROPERTIES OF A THRESHOLD DOSIMETER FOR THE RADIATION STERILIZATION AT 2.5 Mrd. Huebner, K. (Technische Univ., Dresden). Isotopenpraxis; 7: No. 7, 268-72(Jul 1971).

The dosimetric properties of a colorimetric threshold dosimeter

for the radiation sterilization at 2.5 Mrad are given. Especially investigated were such properties as the influence of dose rate and radiation quality on the dose of change, the stability of the change of the color after irradiation, the storage ability of non-irradiated dosimeters, the influence of the atmospheric moisture at the storage, and the effects of temperature during the irradiation on the dose of change. The reproducibility of the dose of change at repeated manufacture of the dosimeter foils and the errors in determining the dose of change are given. The threshold dosimeter foils can be used as visual dose indicators at all irradiations where a determined absorbed dose in the range from 0.2 to 10 Mrad must be proved. (auth)

2322 SILICON PULSE CHAMBER FOR MEASUREMENTS OF X AND GAMMA DOSE RATE. Slapa, M.; Belcarz, E.; Chwaszczewska, J.; Gruzdz, W.; Szymczyk, W. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Instrum. Methods; 96: No. 2, 239-45(1971).

A possibility of improving the energy response of the X and gamma dosemeter with a silicon detector by integrating the charges and not by the number of individual pulses has been investigated. This energy response depends strongly upon the value of the discrimination level E_d. The best results have been obtained for the discrimination level $E_d = 25$ keV and with the 0.8 mm thick Cu corrective filter. In this case the energy response is constant within ±5% for $E_\gamma \geq 180$ keV and within ±30% for 55 keV $\leq E_\gamma < 180$ keV. For the discrimination level $E_d = 50$ keV the energy response is constant within ±7% for $E_\gamma \geq 280$ keV. The dose rate sensitivity in case of the detector active volume of 36 mm^3 may be ranged between 1 mR/h and 20 R/h f.s.d. (auth)

Radiometric Instruments

2323 COMMENTS ON THE MOVING-SOURCE SOIL DENSITY GAUGE. Christensen, E. R. (Technical Univ., Lyngby, Denmark). Nucl. Instrum. Methods; 96: No. 3, 483-4(1971).

Recent experimental results for the moving-source soil density gage are interpreted in terms of the principle of similitude. The interpretation implies that the magnitude of the Id^2 peaks in the (Id^2 vs d) characteristics is determined by the equivalent atomic number Z_{eq} independently of the density ρ. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 2045, 2051, 2069, 2182, 3108, 3822, 3834, 3877, and 3878.

2324 (AAEC/M-86) INSTRUCTION MANUAL FOR DUAL DIGITAL STABILISER TYPE 241. Corran, E. R.; Laman, C. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar 1971. 42p. Dep. NTIS (U. S. Sales Only).

A dual digital stabilizer has been designed which can improve the stability and resolution of most commercially available multichannel analyzers. Its construction and operation are described, together with the modifications necessary for its use with several common commercial analyzers. In its most versatile form the stabilizer can accommodate analyzers with up to 10,000 channels and with clock rates up to 20 MHz. (auth)

2325 (AAEC/TM-592) INVESTIGATION OF THE MEASUREMENT OF VOID-FRACTION IN AIR-WATER MIXTURES BY THE ELECTRICAL IMPEDANCE METHOD. Cybula, G. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jun 1971. 29p. Dep. NTIS (U. S. Sales Only).

An impedance type void meter is described which is suitable for measurement of void-fraction in air-water and steam-water mixtures. The mechanical construction of the meter differs from those previously described in that it minimizes problems with pressure casing penetrations and with sealing of connecting leads. A condensed theoretical analysis of the behavior of the meter in air-water mixtures is included, together with a discussion of possible errors due to changes in conductivity of water and excitation frequency. Two different systems of electronics are described, a series and a bridge type system. An experimental calibration of the prototype meter by the "quick-closing valves method" is compared with the theoretical response and the disagreement arising from the comparison is explained. (auth)

2326 (ANCR-1007) INSTRUMENTATION AND CONTROL BRANCH ANNUAL REPORT, 1970. Smith, G. L. (Aerojet Nuclear Co., Idaho Falls, Idaho). Jul 1971. Contract AT(10-1)-1375. 273p. Dep. NTIS.

ADVANCED TEST REACTOR—fuel elements for, holograph techniques for swage joint tightness of
DISPLACEMENT GAGES—development of variable reluctance, for measurement of reactor core vessel motion,
—development of holographic
EDDY-CURRENT TESTING—equipment for flow detection in ATR fuel elements
EXTENSOMETERS—development of eddy-current diametrical, for testing of pressurized tubular sections
FLOWMETERS—development for use in LOFT testing
—development for spent fuel reprocessing lines
—development of ultrasonic, for liquid sodium
INSTRUMENTS—development at NRTS
LEAK DETECTORS—development of eddy-current, for liquid sodium
LEVEL INDICATORS—development of ultrasonic, for LOFT testing
—development of eddy-current, for liquid sodium
METALS—fatigue testing of, system for
MOTORS—speed control system for
NATIONAL REACTOR TESTING STATION—instrumentation for, development of
PRESSURE GAGES—development of transient, for use in liquid sodium
PUMPS (LIQUID METAL)—current monitor for annular linear induction, harmonic
REACTOR CONTROL SYSTEMS—development of auto-rod servo
REACTOR FUEL ELEMENTS—testing of electrically heated pin type, for coolant loss accident simulation
—cladding for, effects of coolant loss accident conditions on Zircaloy
—fabrication of instrumented pin type, brazing techniques for
REACTOR SAFETY EXPERIMENTS—data acquisition and display system for LOFT
THERMOCOUPLES—corrosion of, effects of pressurized water reactor environment on
—amplifier for fission, differential
THICKNESS GAGES—development of ultrasonic, for plate type fuel elements
VOID FRACTION—detection in steam-water mixture, ultrasonic burst attenuation detector for (TSS)

2327 (CERN-Trans-71-23) TRANSFER OF DATA FROM THE BESM-4 TO THE BESM-6 COMPUTER. Daikovskiy, A. G.; Lumpov, V. N.; Matveev, V. D.; Punjaev, A. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by R. Hodge (CERN, Geneva, Switzerland), from report IFVE-SVM-70-73. 23p. Dep. NTIS (U. S. Sales Only).

The data link for transferring data from the BESM-4 computer to the BESM-6 computer for more rapid data processing is described. (W.H.K.)

2328 (CONF-711111-3) LATE OUTPUT PULSES FROM FAST PHOTOMULTIPLIERS. Stevens, S. S.; Longworth, J. W. (Oak Ridge National Lab., Tenn.). [1971]. 11p. Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

A flash tube and time-to-amplitude converter were used to determine some significant features of the time behavior of fast photomultipliers. Single electron response gives a direct measurement of the distribution of time intervals between excitation of the tube by a single photon and the output pulse for the tube. Results are given for the Amperex XP1023 and RCA 8850. It is found that commonly used fast photomultipliers, when used to time single photons, exhibit a bimodal distribution of effective transit times. (R.W.R.)

2329 (CTH-RF-21) CONTROL OF A 1024 CHANNEL MEMORY BLOCK WITH A SMALL COMPUTER. Grosshoeg, Gudmar (Chalmers Tekniska Hogskola, Goteborg (Sweden). Institutionen for Reaktorfysik). Aug 1971. 49p. Dep. NTIS (U. S. Sales Only).

A small on-line computer has been incorporated into the measuring instrumentation of a reactor physics laboratory. The principles of the hardware and software for an interface between a many channel analyzer (Intertechnique BM 24) and a computer (Digital Equipment PDP-11) are described. Assembler codes, test programs and an implementation in BASIC are given in full details. (auth) (Sweden)

2330 (IFVE-SEF-70-81) ELECTRONIC TIME RELAYS WITH TIME-GENERATING RC CIRCUITS WITH THE DELAYS FROM 1 TO 10 SEC. Rybakov, V. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

A review of papers on electron time relays with long delays is presented with the experimental data on the tests of the parameters of the time relay units (transistors, capacitors) and on the

tests of the time-relay circuit stability. Conclusions have been made on ways of improving the time-relay stability. (auth)

2331 (KFKI-71-42) NEW EQUIPMENT FOR MEASURING STOCHASTIC PROCESSES: STATISTICAL ANALYSER. Pellionisz, Peter (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Aug 1971. 14p. Dep. NTIS (U. S. Sales Only).

The concept of a new statistical measuring set-up is presented. A family of plug-in instrument modules is described. With the set-up one will be able to perform all the typical statistical measurements, such as signal recovery, amplitude and time analysis, correlation computing, etc. The most important types of statistical measurements are summarized; the aimed performances of the equipment are presented; and its application to statistical measuring problems is discussed. (auth)

2332 (SC-R-713263) NANOSECOND PHOTOGRAPHY OF SHOCK-INDUCED ELASTIC RIPPLES. Holland, Richard; Weaver, Douglas L. (Sandia Labs., Albuquerque, N. Mex.). 23 May 1970; Revised 2 Feb 1971. 11p. Dep. NTIS.

When electronic circuitry is exposed to a shock wave of nuclear origin, intense acoustic agitation occurs within each of the components. Obviously, each component must be exceedingly strong mechanically in order to withstand such conditions. This work primarily concerns survival of transistors and integrated circuits. In these devices there is a tendency for elastic or plastic surface ripples to develop on the headers or flatpacks. These ripples previously were quite difficult to record, although they were known to be the primary cause for cracking of transistor chips or microcapacitors from their substrates. However, there is now a system for photographing such motions on polished surfaces. This system is based on incoherent (or geometrical) optics, and thus does not require the use of a massive optically stable bench. Up to 130 frames may be taken in 6.5 μsec at a rate of 50 nsec/frame. It is possible to observe disturbances as small as 100 μm wide by 0.1 μm high, and group velocity may be as fast as 5×10^9 μm/sec. For illustration, photographs of ripples on a transistor header which has been subjected to a shock wave generated by a pulsed electron beam are presented. (auth)

2333 (UCRL-73484) COMPUTER PROCESSING OF RADIOGRAPHIC IMAGES WITH THE FINITE FOURIER TRANSFORM. Ekstrom, M. P.; Rater, O. L. (California Univ., Livermore. Lawrence Livermore Lab.). 14 Oct 1971. 17p. (CONF-711111-11). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

The optimal design and implementation of two-dimensional, nonrecursive digital filters for use in the processing of radiographic images are considered. A stochastic system model is used for the image-forming process, and the filter is designed to a mean-square error criterion. Both the design algorithm and filter realization are mechanized by using a Fast Fourier Transform code, thereby ensuring the computational efficiency of the method. (auth)

2334 TEMPERATURE STABILIZED WIDEBAND OPERATIONAL AMPLIFIER. Karlsson, L. (Royal Veterinary and Agricultural Univ., Copenhagen). Nucl. Instrum. Methods; 96: No. 3, 387-95(1971).

Investigations on a wideband differential input operational amplifier are presented. A temperature stabilized input transistor pair has been utilized. An input offset voltage drift of less than 2 μV/°C at a power bandwidth larger than 5 MHz is obtained. The output stage is able to deliver ±10 V into 50 Ω. (auth)

2335 PROPOSAL FOR AN OPTIMAL CONTROL SYSTEM AND ITS POSSIBLE APPLICATIONS TO THE NUCLEAR FIELD. De Agostino, E.; Putignani, M. G. (CNEN, Rome). Nucl. Instrum. Methods; 96: No. 3, 447-51(1971).

An optimization procedure for the search for an interval containing (with a high degree of probability) the peak of a unimodal function obscured by noise is described. Both the search of the maximum of such a function of a single variable and the reduction of the number of trials are considered. Some proposals for applications in nuclear experiments are made. An example of an application implemented by a PDP-8 computer is described in detail. (auth)

2336 BENT STATISTICAL PACKET OF IDEAL-CRYSTALLINE LAMELLAE AS A HIGH RESOLVING FOCUSING NEUTRON-MONOCHROMATOR-SYSTEM. Frey, F. (Univ., Munich). Nucl. Instrum. Methods; 96: No. 3, 471-3(1971).

A monochromator-system was studied which combines the advantages of perfect crystals with good luminosity. By bending the whole system a focusing effect in ordinary space can be obtained. (auth)

2337 DIGITAL GATE UNIT FOR MULTIPARAMETER PULSE-HEIGHT ANALYSIS. Adachi, Minoru (Tokyo Inst. of Tech.); Fujioka, Manabu; Taketani, Hiroshi; Hisatake, Kazuo; Okuhara, Hiroo. Jap. J. Appl. Phys.; 10: No. 11, 1604-12 (Nov 1971).

A new digital gate unit for multiparameter pulse height analysis is described. The 3-bit comparator which is used to select gate segments in the digital gate unit is described in detail. Performance of this unit in the case of a gamma-gamma coincidence measurement with Ge(Li)-NaI(Tl) detectors is also presented. (auth)

2338 AUTOMATIC TEMPERATURE CONTROL OF A SUPERCONDUCTING BOLOMETER. Khrebtov, I. A.; Gopshtein, N. M.; Zaitsev, G. A. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 292-4(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 247-9(Jan-Feb 1971).

The block diagram of a system for controlling the temperature of a superconducting bolometer is described, and its computation analysis is given. Results are presented for experimental investigations of a system which provides an accuracy of $1.5 \cdot 10^{-5}$ °K. (auth)

2339 PULSE GENERATOR PRODUCING A HIGH-POWER CURRENT. Andrianov, A. M.; Demichev, V. F.; Eliseev, G. A.; (and others). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 124-6(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 112-14(Jan-Feb 1971).

A capacitor bank made up of 16 low-induction KMK-30-8 capacitors is described. For a comparatively low energy capacity of 58 kJ the bank has an intrinsic oscillatory pulse power of $1.4 \cdot 10^{11}$ W and a short-circuit current of 3.5 MA. Low-inductance vacuum spark gaps serve as the current commutators. (auth)

2340 EFFECT OF AN APPLIED ELECTRIC FIELD ON OPTICAL EMISSION FROM A RADIATION PLASMA DEVICE. Thiess, P. E.; Miley, G. H. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc.; 14: No. 2, 430-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2341 SELECTION AND DESIGN OF THE PLUGGING TEMPERATURE INDICATOR FOR FFTF. Caplinger, W. H.; Meadows, G. E.; Bennett, D. W.; Yount, J. A. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 611-13(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2342 DIFFERENTIAL THERMAL ANALYSIS APPARATUS FOR OBSERVATION OF IRRADIATED Pu-CONTAINING REACTOR FUELS. Reavis, J. G.; Brewer, G. R.; Court, D. B.; Schulte, J. W. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 879-80(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2343 REMOTELY OPERABLE PROFILOMETER FOR DIAMETRAL MEASUREMENT OF IRRADIATED AND UNIRRADIATED NUCLEAR FUELS. Carnes, M. D. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: No. 2, 880-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2344 ELECTRO-OPTICAL PROFILOMETER. Lazarus, M. E.; Romanik, T. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 881(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2345 INSTALLATION OF THE SHIELDED ELECTRON MICROPROBE ANALYZER AT ORNL. Long, E. L. Jr.; Miller, J. L. Jr. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 882(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2346 APPARATUS FOR DETERMININING HEAT CONTENT ON IRRADIATED FUELS. Frantz, C. E. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 886(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2347 FORCED-REFLECTION: TYPE OF COLLIMATOR DESIGN. Spencer, L. V. (National Bureau of Standards, Wash-

ington, D. C.); Woolf, Stanley. Trans. Amer. Nucl. Soc.; 14: No. 2, 887(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2348 ATRAIT: SYSTEM FOR THE COLLECTION AND ANALYSIS OF NUCLEAR INFORMATION. Wery, M.; Wittmer, P.; Bueb, B.; Ring, C. (CRN, Strasbourg). Nucl. Instrum. Methods; 96: No. 2, 309-16(1971). (In French).

A system for data collection and analysis is described in the frame of a time sharing process. It is designed to collect the whole data with high priority at the end of an experiment before checking and recording them on a magnetic disk. The data analysis may then be performed at any time by a simple call of the physicist through a conversational code. In the case of a gas target absolute cross sections are obtained. (auth)

2349 FEEDBACK CIRCUIT OF DIGITAL SPECTRUM STABILIZER. Kawarasaki, Y.; Shoji, T. (Japan Atomic Energy Research Institution, Tokai). Nucl. Instrum. Methods; 96: No. 2, 347-9(1971).

A digital spectrum stabilizer which has a direct feedback circuit to an ADC in a pulse height analyzer is described. (auth)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 2212, 2245, 2246, 2318, 2851, 3111, 3112, and 3129.

2350 (N-71-28811) RADIATION EFFECTS DESIGN HANDBOOK. SECTION 1: SEMICONDUCTOR DIODES. Hanks, C. L.; Hamman, D. J. (Battelle Memorial Inst., Columbus, Ohio. Radiation Effects Information Center). Jul 1971. Contract NASw-1568. 41p. (NASA-CR-1785). NTIS.

This document summarizes information relating to steady-state radiation effects on semiconductor diodes and includes an introductory section on terminology. The radiation considered includes neutrons, gamma rays, electrons, and protons. The information is useful to the design engineer for making estimates of radiation effects on diodes. (auth) (STAR)

2351 (N-71-29776) RADIATION EFFECTS DESIGN HANDBOOK. SECTION 3. ELECTRICAL INSULATING MATERIALS AND CAPACITORS. Hanks, C. L.; Hamman, D. J. (Battelle Memorial Inst., Columbus, Ohio. Radiation Effects Information Center). Jul 1971. Contract NASw-1568. 87p. (NASA-CR-1787). NTIS.

Summarized information relating to steady-state radiation effects on electrical insulating materials and capacitors is presented. The information is presented in both tabular and graphical form with text discussion. The radiation considered includes neutrons, gamma rays, and charged particles. The information is useful to design engineers responsible for choosing candidate materials or devices for use in a radiation environment. (auth) (STAR)

2352 (N-71-30648) SOLAR CELL DATA FROM THE RADIATION DAMAGE EXPERIMENT ON SATELLITE ATS-1. Waddel, Ramond C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1971. 298p. (NASA-TM-X-65610; X-710-71-220). NTIS.

Results from the ATS-1 solar cell radiation damage experiment are presented in tabular and graphic forms. The numerical data give the coordinates of eight points on the voltage-current characteristic of each of 29 solar cells during 418 days in synchronous orbit. The cells were of various types, bearing shields of several kinds and thicknesses. Data are presented in both uncorrected and corrected forms. In the latter, the irrelevant effects of varying illumination and temperature are removed. The apparatus, orbit, data processing, and conclusions are also briefly described. (auth) (STAR)

2353 (N-71-31372) RADIATION EFFECTS DESIGN HANDBOOK. SECTION 4: TRANSISTORS. Drennan, J. E.; Hamman, D. J. (Battelle Memorial Inst., Columbus, Ohio. Radiation Effects Information Center). Aug 1971. Contract NASw-1568. 37p. (NASA-CR-1834). NTIS.

Information relating to steady-state radiation effects on transistors is summarized. The radiations considered include neutrons, protons, electrons, and electromagnetic. The information is useful to the design engineer for estimating the effects of radiation on transistors. (auth) (STAR)

2354 (SC-R-713407) NEUTRON INDUCED DEGRADATION AND FAILURE IN HIGH POWER LSA DIODE OSCILLATORS. Wilson, W. E.; Gregory, B. L. (Sandia Labs., Albuquerque, N. Mex.). [Nov 1971]. 10p. Dep. NTIS.

The effects of neutron irradiation on oversized epitaxial GaAs diodes operated in the LSA relaxation mode were studied. The expected material degradation effects are related to circuit performance by use of a simplified circuit analysis which neglects starting and harmonic effects. The experimentally determined material and oscillator characteristics are reported for diodes having two different initial doping concentrations. These results are compared to the theory to obtain general conclusions about the radiation effects on LSA oscillators. (auth)

2355 (UCRL-73236) MAGNETIC THIN-FILM RECORDING SYSTEM FOR FAST TRANSIENTS IN NUCLEAR DIAGNOSTICS. Wichner, R.; Fischer-Colbrie, E.; Buntenbach, R. W.; Condas, G. A.; Hsieh, E. J.; Rufer, R. P.; Vindelov, K. E.; Winslow, J. W.; Brown, D. W.; Mendonca, L. R. (California Univ., Livermore. Lawrence Livermore Lab.). 21 Oct 1971. 26p. (CONF-711111-13). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

The development of a fast transient recording system is described. A magnetic thin film is used to record an electrical signal in the form of a domain wall. The recorder has a risetime on the order of a nanosecond and a dynamic range of better than 30 dB. Readout of the record is compatible with computer (megabit) cycle times. (auth)

2356 PROTON- AND DEUTERON-IRRADIATION DAMAGE IN SILICON SOLAR CELLS. Nashiyama, Isamu; Teranishi, Eizo; Kageyama, Misao (Electrotechnical Lab., Tokyo). Jap. J. Appl. Phys.; 10: No. 11, 1564-74(Nov 1971).

Damages in n-on-p silicon solar cells by proton and deuteron irradiations are investigated in the energy region of 0.8 to 2.8 MeV as functions of the particle-mass, -energy, -fluence and also of the wavelength of the illuminating light. The damage rate due to deuteron irradiation is equivalent to that due to proton irradiation of about 1.8 times the fluence provided both particles have the same range in silicon. The most harmful proton energy to the degradation of short circuit current I_{sc} shifts from the initial value of about 4 MeV down to about 3 MeV with increasing irradiation fluence. Under the illumination by near-infrared light, the degradation of I_{sc} can be approximated by a formula $(I_{sc}/I_{sc0})^{-2} = 8.6 \times 10^{-12} E(MeV)^{1.5} \Phi + 1$ in the energy region below the most harmful proton energy as far as the degradation is not very significant, i.e., $I_{sc}/I_{sc0} > 0.7$. These results can be interpreted satisfactorily by the analysis based on minority carrier diffusion equations in subdivided multilayers in the solar cell which take into account the nonuniformity of damages introduced by the irradiation. (auth)

2357 TL AND EPR STUDIES ON NATURAL CaF_2 AFTER HEAVY GAMMA IRRADIATION. Nambi, K. S. V.; Higashimura, T. (Kyoto Univ.). Radiat. Eff.; 10: No. 3, 197-9(Aug 1971).

Studies were made on the thermoluminescence, and electron paramagnetic resonance (EPR) of a sample of natural CaF_2 which has already been successfully employed in radiation dosimetry. All observations were made after heavily irradiating the phosphor with ^{60}Co gamma rays in the range of 10^5 to 10^9 R at room temperature. Thermoluminescence glow curve studies above room temperature showed that no permanent radiation damage occurred for irradiations till at least 10^9 R. Also a new glow peak at about 320°C was observed for irradiations in this range which may be used in high-level radiation dosimetry. The EPR spectral behavior was explained on the basis of the widely accepted theory of the charge conversion processes of the rare-earth impurities associated with the TL emission. The EPR evidence for such a charge conversion process could be seen only for the first TL peak. The EPR spectrum also revealed the presence of hydrogen in CaF_2 mostly associated with the second TL peak, which may have an important bearing on any model for the TL phenomenon in this sample of natural CaF_2. (auth) (UK)

2358 RADIATION PROPERTIES OF A PHOTOMULTIPLIER IN STEADY-STATE GAMMA-FIELDS. Lyutsko, A. M.; Nguyen Kuang Minh,; Pertsev, A. N.; (and others) (Belorussian State Univ., Minsk). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 224-6(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 190-2(Jan-Feb 1971).

The results of studying the behavior of FÉU-49, -53, -78, 81A, -93, -85, photomultipliers in the γ-fields of ^{60}Co in the dose range up to 10 mR/sec in the spectrometric, one-electron, and current modes are described. (auth)

2359 DIELECTRIC BREAKDOWN IN ELECTRICAL INSULATORS USED IN THERMIONIC CONVERTERS. Britt, E. J.

(Rasor Labs., Kettering, Ohio); Davis, M. V. Trans. Amer. Nucl. Soc.; 14: No. 2, 575-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2360 INDIVIDUAL TRANSISTOR GAIN PERFORMANCE IN A NEUTRON FLUX. Dreyer, Howard S. (Pioneer Service and Engineering, Chicago). Trans. Amer. Nucl. Soc.; 14: No. 2, 579 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2361 QUANTITATIVE DESCRIPTION OF PROCESSES OF RADIATION AGING OF PLASTIC SCINTILLATORS. Ekkerman, V. M.; Gunder, O. A.; Koba, V. S. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 883-4(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 907-8(Nov-Dec 1970).

A quantitative study of the process of radiation aging of plastic scintillators was made using experimental data on the light output of samples based on polystyrene, subjected to irradiation by a $^{90}Sr-^{90}Y$ source. (D.H.M.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Basic Processes

Refer also to abstract 2416.

2362 XVIII INTERNATIONAL DAIRY CONGRESS. VOLUME 1E. Conference Held at Sydney, October 12–16, 1970. Sydney; International Dairy Congress Editorial and Technical Committee (1970). 721p. (CONF-701059–(Vol.1E)).

Separate abstracts were prepared for three papers presented at the conference. (H.L.W.)

For abstracts of individual papers see: 2363, 2372, and 2446.

2363 RADIOISOTOPIC TECHNIQUE FOR THE RAPID DETECTION OF COLIFORM ORGANISMS IN MILK AND MILK PRODUCTS. Koga, Y. (Tokyo Univ.); Tsugo, T.; Aibara, K. pp 150 of XVIII International Dairy Congress. Vol. 1E. Sydney; International Dairy Congress Editorial and Technical Committee (1970).

From eighteenth international dairy congress; Sydney, Australia (12 Oct 1970). See CONF-701059–(Vol.1E).

Investigations were performed to see in how short a period it is possible to detect $^{14}CO_2$ liberated from lactose-1-^{14}C added to a medium in which coliform organisms from milk to milk products were growing. Generation times obtained from oft repeated determination with E. coli, K. aerogenes and C. freundii were 21.5, 26.1 and 30.0 min respectively. A reliably detectable amount of $^{14}CO_2$ was liberated when the total cell number taking part in the gas formation reached 10^4–10^5/ml. (Australia)

2364 RADIOIMMUNOLOGICAL DETERMINATION OF INSULIN IN NORMAL AND PREGNANT WOMEN. del Olmo, J.; Catalan, R. E.; Villa, T.; (and others) (Facultad de Medicina, Madrid). Energ. Nucl. (Madrid); 15: No. 71, 225-34(May-Jun 1971). (In Spanish).

Precise radioimmunoassay techniques were developed for the determination of insulin in blood plasma of diabetic and prediabetic pregnant women. Two types of results were obtained, one of which corresponded to prediabetics and the other corresponds to diabetic pregnant women. It was concluded that in the normal pregnant woman there is an elevation of the insulin reserve in contrast to non-pregnant women of the same age. (tr-auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 1822, 1823, 2378, and 2437.

2365 QUANTITATIVE DETERMINATION OF $^{14}CO_2$ BY SCINTILLATION SPECTROMETRY IN METABOLIC STUDIES IN VIVO. Nemec, R.; Cerven, J.; Ginter, E. (Inst. of Human Nutrition, Bratislava). Physiol. Bohemoslov.; 20: No. 3, 281-6(1971).

A simple and reliable method for determining the amount of expired $^{14}CO_2$ in metabolic studies in vivo was evolved. The method is based on the absorption of $^{14}CO_2$ into ethanolamine directly in the scintillation vials and on subsequent measurement of activity by means of liquid scintillation spectrometry. The construction of a simple metabolic chamber suitable for work with laboratory animals up to the size of an adult guinea pig is described. (auth)

2366 FACTORS AFFECTING THE ENTRY OF INTRATISSULARLY ADMINISTERED COLLOIDAL ^{198}Au INTO LYMPHATIC GLANDS. Shcheglov, S. M. Cesk. Radiol.; 24: No. 5, 208-14(Sep 1970). (In Russian).

In albino rats, the effect was studied of age and of the development of a tumor process on the transfer of colloidal radioactive gold, ^{198}Au, to the lymphatic glands after an intratissular injection. In animals of various age, marked differences in the transfer of the radiocolloid to the glands were observed. In animals with a developing tumor (infectious sarcoma 45 and M-1), a considerably lower quantity of colloidal ^{198}Au was found in the lymphatic glands than in control animals. The results can be explained mainly by changes in the connective tissue which depend on the growth of the organism or of the tumor. These changes thus affect the transfer of colloids administered into the lymphatic system of the tissue. This may be one of the reasons for the negligible transfer of radioactive colloidal gold to the glands in intratissular application of the preparation during clinical treatment. (NSA of Czech)

2367 TRITIATED THYMIDINE LABELING OF NORMAL AND NDV-INFECTED CHICK NASAL EPITHELIAL CELLS. Ota, Wesley K.; Bang, Betsy G.; Bang, Frederik B. (Johns Hopkins Univ., Baltimore). Proc. Soc. Exp. Biol. Med.; 137: No. 4, 1278-82(Sep 1971).

The tritiated thymidine labeling index in nasal turbinate epithelia was determined in chicks which had been infected 24 hr with Newcastle disease virus and in control chicks. Control indices were calculated at periods from 1 hr to 18 days, indices in infected epithelia at two hr intervals 1–57 hr after thymidine injection. Mean control values were consistently higher in outer-surface epithelia than in the shallower inner-surface system (3.0 : 1.1); peak labeling was 12 hr. The proliferative compartment in the ciliated cell system was between basal stem cells and superficial end cells; 7% of labeled cells were in the end cell position at 48 hr; about 40% were in this position at all periods between 7 and 18 days. Indices were sharply reduced in infected turbinates in all compartments in all mucociliated epithelia at all times between 25 and 81 hr postinoculum. Lymphocyte control indices peaked at 12 hr, fell somewhat below control value for 35 hr post-infection. Indices in turbinate cartilage cells were 0.6% in controls, 0.1% in infected chicks. (auth)

2368 TISSUE ISOTOPE CLEARANCE. II. REDUCTION OF CLEARANCE BY PENTOBARBITAL INFUSION. Gangarosa, Louis P. (Medical Coll. of Georgia, Augusta). Proc. Soc. Exp. Biol. Med.; 137: No. 4, 1372-4(Sep 1971).

The clearance of a substance from a subcutaneous injection site is influenced by the depth of pentobarbital anesthesia. ^{131}I-4-iodoantipyrine showed an initial clearance rate of 9.4%/min after subcutaneous injection in anesthetized control female rats. Pentobarbital Na was infused at progressively increasing rates, resulting in a fall in blood pressure proportionate to the dose of barbiturate. With the fall in blood pressure a progressive fall in initial clearance rate of the injected isotope was also noted; after death no further clearance occurred. The data supports Kety's hypothesis that the clearance rate of a rapidly diffusible substance depends upon circulatory efficiency. (auth)

2369 STUDIES ON BASIC CHARGED MOLECULES AND CELL MEMBRANES IN CYSTIC FIBROSIS. Benke, P. J.; Herrick, Norma; Pitot, H. C. (Univ. of Wisconsin, Madison). Proc. Soc. Exp. Biol. Med.; 137: No. 4, 1283-8(Sep 1971).

A recent hypothesis is that unknown positively charged molecules are involved in the pathophysiology of cystic fibrosis. ^{131}I-albumin uptake by sarcoma 180 cells in culture, 1-4-^{14}C-succinate oxidation by isolated mitochondria and ^{35}S-thiamine released by cultured fibroblasts are affected by poly-L-lysine, a positively charged polypeptide. CF saliva does not have this effect. Polyacrylamide gel electrophoresis and acrylamide isoelectric focusing suggests that basic secretory proteins are normal in CF saliva. Conventional pancreatic replacement therapy does not affect basic charged secretory proteins as it does in experimental animals. (auth)

2370 PERIPHERAL METABOLISM OF THYROXINE IN THYROIDECTOMIZED RATS TREATED WITH CORTISONE. McHugh, William B.; Yatvin, Milton B. (Univ. of Wisconsin, Madison). Proc. Soc. Exp. Biol. Med.; 137: No. 4, 1307-10 (Sep 1971).

The present study supports the conclusion that cortisone, administered to thyroidectomized, thyroxine-maintained rats does not alter their ability to deiodinate peripheral thyroxine. This is based on the observation that in two separate experiments there was no demonstrable cortisone effect on the level of serum protein-bound protein iodine. In addition, there was no significant difference between control and cortisone-treated animals in regard to either their urinary or fecal ^{125}I excretion as well as no difference in total excretion of radioactivity. (auth)

2371 EARLY DETECTION AND CLASSIFICATION OF RENAL TRANSPLANT REJECTION BY B/K SCAN RATIO AND BLOOD ISOTOPE CLEARANCE DATA. Hayes, Michael; Moore, Thomas C. (Univ. of California, Los Angeles). Contract AT(04-1)-Gen-12. Transplantation; 12: No. 2, 139-41(Aug 1971)

A decreased B/K ratio appears to be one of the earliest and most sensitive indicators of acute allograft rejection. The relationship of the B/K ratios to blood isotope clearance indices also provides a potentially useful means of distinguishing between acute and delayed hyperacute (accelerated) rejection in the initial 2 weeks posttransplant. A decreased blood isotope clearance may be one of the earliest indications of the delayed hyperacute-type rejection. Caution is urged in the evaluation of post-transplant increased ^{131}I-hippurate blood clearance and scan

evidence of increased transplant ^{131}I-hippurate uptake. These may be indicators of trouble rather than signs that all is well. B/K ratios are easily and safely obtained and, with blood isotope clearance studies, may be of considerable value in the early detection and type identification of transplant rejection in the initial weeks after allografting. (auth)

Radiation Effects

Refer also to abstracts 2362, 2430, 2432, and 2446.

2372 VOLATILE COMPONENTS IN CASEIN AFTER EXPOSURE TO UV LIGHT. Ramshaw, E. H.; Leary, J. (CSIRO, Melbourne). pp 64 of XVIII International Dairy Congress. Vol. 1E. Sydney; International Dairy Congress Editorial and Technical Committee (1970).

From eighteenth international dairy congress; Sydney, Australia (12 Oct 1970). See CONF-701059-(Vol.1E).

The quantity of volatile components in uv-treated casein was ca. twice that in stored casein. The major components were benzaldehyde, nonanal, octanal, heptanal, hexanal and dimethyl disulfide and there were significant quantities of hex-2-enal, hept-2-enal, oct-2-enal, hexa-2,4-dienal and hepta-2,4-dienal. A number of other components which had potentially important odors (potato; weedy) remained unidentified. Examination of the degradation products of uv-treated casein containing added tryptophan revealed a peak with retention behavior and odor similar to that of the weedy component and this was identified as benzyl methyl sulfide. The residue of the initial distillate contained major quantities of indole and skatole and minor amounts of phenol, cresol and o-amino-acetophenone. The predominant flavoring compounds in uv-treated casein appeared to be the indole and skatole and to a lesser extent the unsaturated aldehydes and benzyl methyl sulfide. It differed from casein with heat-induced degradation in the presence of alk-2-enals, alka-2,4-dienals, indole and skatole and in the absence of furan derivatives and alkan-2-ones. (Australia)

2373 RADIOPROTECTION OF DEOXYRIBONUCLEIC ACID BY 4-MERCAPTO-PYRIDOXINE IN VITRO: AN EPR STUDY. Van de Vorst, A. (Univ., Liege); Beaumariage, M.-L.; Van Caneghem, P.; Bacq, Z. M.; Goutier, R. Atomkernenergie; 18: No. 2, 101-4(1971).

The possibility of radioprotection of DNA by 4-mercaptopyridoxine in vitro has been studied by EPR method. When freeze-dried solutions containing these two molecules are irradiated by x-rays at room temperature, the proportion of radiation-induced sulfur radicals increases with increasing proportion of DNA in the mixture. On the other hand, when calculated from the slope at the origin of the curves relating the number of paramagnetic centers with the radiation dose, the values of the radicals yield are abnormally high and cannot result from a direct action of ionizing radiation on the thiol, but suggest the existence of a protective effect on DNA of 4-mercaptopyridoxine acting as a radical scavenger. A comparison is discussed between the present observation and the observation made in vivo. (auth)

2374 HIGH OXYGEN EFFECT FOR THE RELEASE OF ENZYMES FROM ISOLATED MAMMALIAN LYSOSOMES AFTER TREATMENT WITH IONIZING RADIATION. Watkins, D. K. (Hammersmith Hospital, London). Advan. Biol. Med. Phys.; 13: 289-305(1970).

Rats were sacrificed by cervical dislocation and excised organs were homogenized; the homogenate was then fractionated and the crude lysosomal suspension was used in all experiments. After treatment, free enzyme was determined by centrifuging the lysosome suspension and assaying the separate activities in the supernatant and precipitate fractions. Methods for assay of enzymes are described. The lysosome suspensions were irradiated in a hollow gas-tight wheel to facilitate rapid exchange between the liquid and air or nitrogen. Accumulating doses of electrons, from a 7 MeV linear accelerator, were given to the lysosomes at dose rates of 5 krad/min for doses up to 5 krad, and 45 krad/min for higher doses. Graphs are presented to show the release of β-glucuronidase, β-glucosaminidase, and acid phosphatase from lysosomes after irradiation. Irradiation of lysosomes suspended in sucrose resulted in a depression of the sucrose resulted in a depression of the activities of some of the enzymes. Loss of enzyme activity paralleled the radioinduced release of enzymes in that inhibition was not apparent immediately following irradiation in air nor at any time after irradiation in nitrogen. Enzyme interactions and states within the lysosome are discussed. (H.L.W.)

Immunology

2375 EFFECT OF IRRADIATION ON ADOPTIVE IMMUNIZATION IN EXPERIMENTAL ALLERGIC ENCEPHALOMYELITIS. Purdy, C. W.; Loan, R. W. (Univ. of Missouri, Columbia). Int. Arch. Allergy Appl. Immunol.; 40: No. 6, 842-50(1971).

X-irradiation (600 R) of Lewis strain recipient rats had no effect on subsequent adoptive immunization with encephalitogen-sensitized lymph node cells. Adoptive immunization with irradiated (200–600) R) encephalitogen-sensitized lymph node cells resulted in clinical signs of experimental allergic encephalomyelitis (EAE), and a reduced number of histopathologic lesions. Irradiation of both recipients and sensitized donor cells resulted in clinical signs, but only mild lesions of EAE. Subsequent injection of "nonsensitized" lymph node cells did not increase the severity of EAE in these animals. The results suggested that the production of clinical signs by radioresistant sensitized lymphoid cells was not dependent upon interaction with radiosensitive lymphoid cells. Radiosensitive cells, however, appeared to be important for optimal development of microscopic lesions (auth)

2376 EFFECT OF IN VITRO IRRADIATION OF CELLS IN GRAFT-VERSUS-HOST REACTIONS. Biggar, W. D.; Meuwissen, H. J.; Good, R. A. (Univ. of Minnesota, Minneapolis). Proc. Soc. Exp. Biol. Med.; 137: No. 4, 1274-7(Sep 1971).

Mice were injected intraperitoneally with irradiated spleen cells of parental A strain; controls were injected with nonirradiated spleen cells. Eight days after injection, the animals were killed, their body and spleen weights were determined, and a relative spleen weight was calculated. The spleen index was determined by dividing the mean relative spleen weight of the experimental groups by the mean relative spleen weight of the negative control. Results are presented in the form of a graph showing spleen indicies of mice following injection of normal cells, cells irradiated with 1500 R, and cells irradiated with 2000 R. Results demonstrated that in vitro irradiation effectively inhibited a sufficient proportion of immunocompetent cells to keep the hazard of GVH to a minimum. However, irradiation in moderate doses may leave a residue of cells capable of initiating a GVH reaction. (H.L.W.)

Ecology

Refer also to abstracts 2386, 2388, 2391, 2393, 2434–2436, and 2443.

2377 (HEDL-TME-71-109) ENVIRONMENTAL ENGINEERING PROGRAMS QUARTERLY TECHNICAL PROGRESS REPORT, APRIL–JUNE 1971. Hofmann, P. L. (comp.) (Hanford Engineering Development Lab., Richland, Wash.). Jul 1971. Contract AT(45-1)-2170. 43p. Dep. NTIS.

Computer programs (TOPLYR) were developed for use in calculations of the dispersion of thermal energy in effluents released by nuclear power reactors in bodies of water. A survey was made on the direct cooling capacities of North and Middle Atlantic rivers. Preliminary results are reported from a study of beneficial uses that may be made of thermal effluents released from nuclear power reactors. (C.H.)

2378 (RLO-2225-T-1-7) OYSTER RESEARCH WITH RADIONUCLIDES. Nelson, Victor A.; Seymour, Allyn H. (Washington Univ., Seattle. Lab. of Radiation Ecology). 1 Sep 1971. Contract AT(45-1)-2225. 20p. (CONF-710634-1). Dep. NTIS.

From sixty-third annual meeting of National Shellfisheries Association; Seattle, Wash. (20 Jun 1971).

The use of radionuclides in molluscan research can be useful for the shellfish biologist just as the use of molluscs for radioecological research can be useful to radioecologists. Radioecological studies are summarized and the uses of radionuclides in oyster research are reviewed. Major uses of oysters in radioecological studies which are discussed are the determination of the effects of radiation on the larvae of the Pacific oyster, Crassostrea gigas, and the distribution of radionuclides in the environment as indicated by molluscs. Uses of radionuclides in oyster research discussed are depuration studies using radionuclides; the use of radionuclides as metabolic tracers; determination of filtration and feeding rates using radionuclide-tagged algae; determination of shell formation and growth rate; radionuclides as a field tag; trace element determination by activation analysis; and genetic studies using radiation-increased mutation rates. (auth)

2379 (RLO-2227-T-12-10) ECOLOGICAL STUDIES OF RADIOACTIVITY IN THE COLUMBIA RIVER ESTUARY AND ADJACENT PACIFIC OCEAN. Progress Report, July 1, 1970–June 30, 1971. McCauley, James E. (comp. and ed.) (Oregon State Univ., Corvallis. Dept. of Oceanography). Jul 1971. Contract AT(45-1)-2227. 235p. Dep. NTIS.

Abstracts of the following theses on marine radioecology are presented: a comparative study of the infauna of the central Oregon continental shelf; swimbladder morphology and buoyancy of

northeastern Pacific myctophids; determination of ^{65}Zn specific activity in various tissues of the California sea mussel, Mytilus californianus; the copepods in a collection from the southern coast of Oregon; growth of a sea urchin, Allocentrotus fragilis, at different depths off the Oregon coast; the concentration and oxidation state of chromium in seawater; non-biological uptake of ^{65}Zn from a marine nutrient medium; and ^{65}Zn uptake by a bacterium isolated from Alder Slough, Columbia River Estuary. Additional research in progress is reported as follows: ^{65}Zn specific activity in mussels from the Oregon coast; sorption of radionuclides on sediment; sediment organic matter and ^{65}Zn in sediment; ^{65}Zn uptake by estuarine isopods; radionuclides in detritus; radionuclide retention in freshwater clams; ^{152}Eu in Columbia River sediment; concentration of ^{228}Ra by calcareous benthic organisms; mercury and zinc in Pacific hake; fallout observations; sorption of radionuclides on sediment; comparison of field and laboratory processes; post shutdown radionuclide transport study; seawater leaching of radionuclides from sediment; cobalt assimilation by marine phytoplankton; cycling of radionuclides in the Columbia River estuary; ^{65}Zn specific activities of neritic animals; benthic ecology and radioecology; Callianassa californiansis in Yaquina Bay; non-biological uptake of ^{65}Zn from a marine algal nutrient medium; food sources of sublittoral, bathyal, and abyssal asteroids in the Northeast Pacific Ocean off Oregon; recent Ophiuroidea occurring off Oregon; a redescription of Ophicantha rhachophora and a description of a new species of ophiuroid; biological fouling on Totem-1, a deep-sea spar buoy; a notacanthid Macdonaldia challengeri off the Oregon coast; radioactivity in juvenile Columbia River salmon; a model to interpret movement and feeding habits; specific activity of ^{55}Fe in Pacific salmon; ^{65}Zn specific activity in Mytilus californianus tissues; ^{65}Zn in Oregon–Washington continental shelf sediments; seasonal radionuclide inventories in Alder Slough, an ecosystem in the Columbia River estuary; the rate of zinc uptake by Dover sole in the Northeast Pacific Ocean; preliminary model and analysis; size, structure, and growth rate of Euphausia pacifica off the Oregon coast; growth and reproduction of the lanternfish Stenobrachius leucopsarus; slide rule conversion of per cent transmittance to absorbance; two new parasites (Protozoa) from the spatangoid-urchin Brisaster latifrons; and determination of movement and identity of stocks of Coho salmon in the ocean using the radionuclide ^{65}Zn. (H.L.W.)

2380 MECHANISM OF GRAIN CONTAMINATION BY RADIONUCLIDES. Nierle, W.; Ocker, H.-D. Ber. Getreidechem.-Tag., Detmold; 101-14(1969). (In German).

At various growth periods, wheat and barley plants were contaminated with carrierfree solutions of ^{85}Sr, ^{54}Mn, ^{60}Co, and ^{134}Cs. Leaf contamination with ^{85}Sr and ^{54}Mn lead to little grain contamination when applied prior to ear formation. A ten- to twentyfold increase of radioactivity occurred when the plants were sprayed during the flowering period. Later contaminations showed a decreased deposition in the grain. ^{85}Sr content in various components, obtained during milling of the grain, depended on the growth period during which contamination occurred. Such a dependency was not found for ^{54}Mn, ^{60}Co, and ^{134}Cs. Leaf contamination prior to ear formation also caused soil contamination and, thereby, uptake through roots. Decontamination of grain with a solution of phosphoric acid showed a strong dependency of efficiency on the time of contamination. If contamination occurred prior to ear formation, only 20% of the radioactivity could be removed from the grain; with contamination after the flowering period, more than 90% could be removed. (H.B.G.)

2381 MODELING OF WATER TRANSPORT OF RADIONUCLIDES. Peterson, D. E. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 458-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Genetics and Cytogenetics

Refer also to abstracts 2362, 2378, 2437, and 2446.

2382 (CALT-767-P-5-X-2) MUTATIONAL ANALYSIS OF DEVELOPMENT IN DROSOPHILA MELANOGASTER. Annual Progress Report. Lewis, Edward B. (California Inst. of Tech., Pasadena. Div. of Biology). 30 Aug 1971. Contract AT(04-3)-767. 5p. Dep. NTIS.

Irradiation with x-rays was used to synthesize several genetic tools for analyzing how the bithorax gene cluster in Drosophila controls the pattern of development of certain major body segments. Specifically, x rays were used to synthesize two types of small free duplications carrying cytological (quinacrine-fluorescing regions) and genetical markers along with either the wild-type genes of the bithorax gene cluster; or the regulator-like mutant, Rg-pbx, which appears to repress specifically, and in a variegated manner, the action of one of the genes of the bithorax cluster. A rearrangement has also been induced with x rays which establishes the autonomous nature in somatic tissues of a general suppressor gene in Drosophila, namely, the suppressor of Hairy-wing gene, which acts like a nonsense suppressor, and which suppresses certain specific alleles of genes in the bithorax cluster, as well as of other unrelated loci. These duplications and rearrangements should prove valuable for analyzing the way in which genes in a high organism are regulated during development of the organism. (auth)

2383 INFLUENCE OF TEMPERATURE ON THE INDUCTION AND REPAIR OF RADIATION INDUCED ABERRATIONS IN THE HUMAN CHROMOSOME. Bora, K. C.; Soper, L. (Dept. of National Health and Welfare, Ottawa). Can. J. Genet. Cytol.; 13: 364-8(Jun 1971).

Investigations were carried out by x-irradiating human peripheral blood lymphocyte cultures in vitro at 37 or 5°C with 306 R at 102 R/min, and maintaining these at the respective temperatures for 65 min following irradiation, and before incubation at 37°C, and by reversing the temperature of half the cultures immediately or 30 min following irradiation. Metaphase chromosomes were analyzed in 54-hr cultures for induced aberrations. Aberration frequency was significantly higher in cultures irradiated at 37°C and maintained at 37°C for 65 min following irradiation than in cultures receiving parallel treatments at 5°C. Reversal of temperature from 37 to 5°C and vice versa resulted in intermediate frequencies. Reduction of post-irradiation treatment time from 65 to 30 min at 37°C before reversal to 5°C did not influence the exchange frequency. However, similar treatment at 5°C and reversal to 37°C showed an increase. It is suggested that the increase in the aberration frequency at high temperature is not due to an enhanced sensitivity of the human chromosome to radiation, but to an influence on the repair and exchange formation processes. (auth) (Canada)

2384 FREQUENCY OF CHROMOSOMAL TRANSLOCATIONS AMONG THE OFFSPRING OF LOCALLY IRRADIATED RATS. Savkovic, N.; Pecevski, J. (Boris Kidric Inst. of Nuclear Science, Belgrade). Can. J. Genet. Cytol.; 13: 283-6(Jun 1971).

The aim of our investigation was to examine the frequency of chromosomal translocations among the male F_1 generation of rats at the first metaphase stage of meiosis. Cytological examination of primary spermatocytes of the offspring of rats was made 12 weeks after they were born. The results obtained show that irradiation induces chromosomal translocations in male offspring originating from irradiated parents. (auth) (Canada)

2385 X-RAY-INDUCED MUTANTS IN LACTIC ACID BACTERIA. Dilanian, Y.; Markarian, K.; Sarkisya, R. (Erevan Zoo-Veterinary Inst.). pp 122 of XVIII International Dairy Congress. Vol. 1E. Sydney; International Dairy Congress Editorial and Technical Committee (1970).

From eighteenth international dairy congress; Sydney, Australia (12 Oct 1970). See CONF-701059-(Vol.1E).

The possibility of accelerating the cheese ripening process by x-ray induced proteolytically enhanced bacteria was exemplified by introduction of such mutagenic strains of lactobacilli into rindless cheese. X-ray induced lactobacilli mutants had absolute activity which exceeded by 30 to 50% that of the best strains of this species available before irradiation. It is thought that the amount of individual amino acids that characterize a particular cheese variety may soon be controllable. (Australia)

Health Physics and Safety

Refer also to abstracts 2584 and 3448.

Radioactive Contamination and Decontamination

Refer also to abstracts 2381, 2393, and 2395.

2386 (GAT-660) ENVIRONMENTAL RADIOACTIVITY LEVELS AND CONCENTRATIONS, SEMIANNUAL SUMMARY, FIRST HALF 1971. Emler, V. S.; Eyre, J. J.; Kalmon, B.; Shepherd, R. E.; Trivisonno, C. F.; Wiehle, W. E. (Goodyear Atomic Corp., Piketon, Ohio). 17 Sep 1971. Contract AT(33-2)-1. 9p. Dep. NTIS.

The average and maximum levels of radioactivity in the ambient environment surrounding the Portsmouth Gaseous Diffusion Plant during the first half of 1971 are summarized. None of the averages of air samples from the various locations exceeds one percent of the applicable Radioactivity Concentration Guide. Maximum radioactivity in water was in samples taken from the drainage ditch serving the northeast portion of the plant; activity was 1.10 percent and 44.0 percent of RCG for alpha and beta–gamma, respectively. Maximum levels decreased to 0.02 percent for alpha and .20 per-

cent for beta–gamma upon ultimate flow into the Scioto River. These values are not significantly different from those measured in the river upstream from the point of influence of waste waters from the plant. (auth)

2387 (RT/PROT–(70)38) AMOUNT OF ^{85}Kr, ^{131}I, ^{90}Sr, ^{239}Pu, AND TRITIUM RELEASED CONTINUOUSLY TO THE ATMOSPHERE AROUND THE EUREX REPROCESSING PLANT. Cagnetti, P.; Frittelli, L. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 4 Jan 1971. 23p. (In Italian). Dep. NTIS (U. S. Sales Only).

The amount of airborne radioactive wastes which can be safely released into the environment of the EUREX fuel reprocessing plant was determined on the basis of demographic, ecological, and meteorological informations collected on the site. Since the meteorological data are inadequate, calculations were made using the more cautious assumptions based on the Val Padana climatology, that include a safety factor. The potential release of ^{85}Kr, ^{131}I, ^{90}Sr, ^{239}Pu, and tritium was calculated. (auth) (TSS)

2388 (TID–25845) TREATMENTS FOR FARMLAND CONTAMINATED WITH RADIOACTIVE MATERIAL. Agriculture Handbook No. 395. Menzel, R. G.; James, P. E. (Agricultural Research Service, Beltsville, Md.). Jun 1971. 18p. GPO $0.20.

There are many possible sources of radioactive material that could contaminate farmland, ranging from widespread fallout from the explosion of nuclear weapons to a very limited spread from a transportation accident involving radioactive material. The explosion of nuclear weapons could result in contamination of thousands of square miles. Contamination from a very severe reactor accident might affect several hundred square miles. In transportation accidents the contaminated area would probably be less than one acre. A decision to treat the contaminated area will require consideration of several complex factors, including: the immediate and long-term hazard presented by the location and nature of the radioactive material; the hazard likely to remain after treatment; other consequences of the treatment, such as radiation exposures to the persons carrying out the treatment and changes in productivity of the treated land; and the availability of machinery and manpower for treatment. It may be unnecessary to treat contaminated land if the radioactive material is short-lived and the area can be isolated until it decays. If the area of contamination is large, the quantity of readily available resources might be lacking for desirable treatment of all areas at once. In that case, careful judgment will be required to recommend which areas should be treated first and what methods should be used. Since the choice of treatment may depend on the objectives of treating any given area of contamination, it is necessary to define the objectives clearly. These could be one or more of the following: preventing spread of the radioactive material to other areas; reducing the radiation hazard to persons who must live or work in the area; and reducing the entry of the radioactive material into food products derived from the contaminated land. Some treatments are better suited to one objective than to another. The urgency of treatment would likewise depend on the objectives. Immediate action might be essential for preventing spread of radioactivity or reducing the radiation hazard, but not for reducing the radioactivity in crops. Immediate action might increase greatly the radiation exposures to the persons carrying out the treatment. In each case of contamination, the hazards of immediate treatment should be balanced against those of delaying or foregoing treatment. In many cases, the main objective of treating contaminated farmland would be to reduce the entry of radioactive material into food products. This would be true if relatively long-lived and biologically active radionuclides, such as ^{45}Ca, ^{65}Zn, ^{89}Sr, or ^{90}Sr were present in appreciable quantities. In fallout from nuclear explosions the strontium radionuclides are very important. Since they often constitute the main hazard, the effectiveness of some treatments was evaluated by the reduction in uptake of radiostrontium. Two kinds of treatments were evaluated. The first kind, which may be called decontamination, includes methods of removing radioactive material from farmland. The second kind includes methods of treating land to reduce the uptake of radioactive materials by crops without decontaminating. Alternatives to treating contaminated land are discussed to give a broader perspective on the techniques of managing contaminated land. (36 references) (C.H.)

2389 AIR TRANSPORT MODELING FOR REGIONAL DOSE STUDIES. Dotson, W. Leon (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 458(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2390 ETIOLOGY OF CHRONIC HEMATURIA IN CATTLE. Chonka, I. A.; Voloshin, P. P. Veterinariya; 9: 90-1(Sep 1970). (In Russian).

According to a previous worker (Moroshkin) chronic hematuria was induced in big-horned cattle by the presence of radioactivity in the vegetation and the water consumed by the animals. In order to check this report, six farms were established for the new study: 3 in mountainous regions, 2 in the foothills, and one in the low flatlands. Two of these farms had been included in Moroshkin's report. A systematic investigation from 1963 to 1968 showed that the total beta activity of vegetation varied within fixed limits, depending upon the micro-zone, on the amount of atmospheric fallout, and altitude above sea level. The total beta activity of the food of animals grown on mountainous farms was higher than that on low-lying farms, and the gamma background was also higher. The present data do not confirm Moroshkin's findings. (K.S.W.)

2391 AMBIENT RADIOACTIVE CONTAMINATION: ATMOSPHERE, RAINWATER, AND FOOD PRODUCTS. Orbe Murillo, Freddie; Salazar J., Magdalena. Politecnica (Quito); 1: No. 2, 89-117(1968). (In Spanish).

The radioactivity of the atmosphere, rainwater, food products, and milk was measured in Ecuador from August 1, 1966, to May 31, 1967. The results are tabulated. (J.S.R.)

Dosimetry and Monitoring

Refer also to abstracts 2201–2203, 2213, 2389, 3070, and 3593.

2392 (ICRU–19) RADIATION QUANTITIES AND UNITS. (International Commission on Radiation Units and Measurements, Washington, D. C.). 1 Jul 1971. 24p.

This report supersedes ICRU Report 11. The major changes include the introduction of additional quantities particularly in the areas of microdosimetry and radiation protection and also more rigorous definitions of the quantities resulting in a somewhat different formalism without altering their meaning or range of applicability. (W.H.K.)

2393 (NP–19067) CONTROLLING EMPLOYEE EXPOSURE TO ALPHA RADIATION IN UNDERGROUND URANIUM MINES. VOLUME 2. APPENDIXES FOR THE USE OF RADON-DAUGHTER CONTROL SPECIALISTS. Rock, R. L.; Dalzell, R. W.; Harris, E. J. (Bureau of Mines, Washington, D. C.). 1971. 180p. GPO $4.00.

Methods for the control of the environment in uranium mines are presented. Emphasis is placed on methods for protection of mining personnel against airborne α activity. A basic guide to ventilation system testing, a discussion of Rn daughter sampling instruments and their calibration, a guide to air sampling procedures, a discussion of the performance of exposure-recording devices to be worn by uranium miners, and methods for the maintenance of employee radiation exposure records are included. (C.H.)

2394 LIVING PATTERNS MODEL FOR REGIONAL DOSE STUDIES. Jacobson, L. D. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 459(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2395 MODELING OF ENVIRONMENTAL PATHWAYS AND RADIATION DOSES FROM NUCLEAR FACILITIES. Soldat, J. K. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 459-60(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2396 NEW PERSPECTIVES ON ENVIRONMENTAL RADIATION MONITORING AROUND NUCLEAR FACILITIES. Beck, H. L.; Lowder, W. M.; Gogolak, C.; DeCampo, J.; McLaughlin, J. E. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 464(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2397 RADIATION ABSORBED DOSE: METHOD OF CALCULATION AND CLINICAL IMPLICATIONS. Smith, Edward M. (Univ. of Miami, Miami Beach, Fla.). Trans. Amer. Nucl. Soc.; 14: No. 2, 521-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2398 CALCULATION OF DEPTH-DOSE DISTRIBUTIONS PRODUCED IN TISSUE BY NEGATIVE PIONS. Armstrong, T. W.; Alsmiller, R. G. Jr.; Chandler, K. C. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 523(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2399 RADIOLOGICAL DOSE CALCULATION IMPROVEMENTS. Bonzon, L. L.; Rivard, J. B. (Sandia Labs., Albuquerque, N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 772-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2400 SIMPLIFIED MODEL FOR ESTIMATING SPACE PROTON DOSE TO DISTRIBUTED BODY ORGANS. Billings, M. P.; Langley, R. W. (McDonnell Douglas Astronautics Co., Huntingtor Beach, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 908-9(Oct 1971)

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2401 PRELIMINARY DOSIMETRY FOR NEUTRON IRRADIATION OF SEEDS IN THE TSING HUA REACTOR IRRADIATION FACILITY. Tsai, Chao-ming; Yu, Bin; Yu, Pei (National Tsing Hua Univ., Taiwan). Nucl. Sci. J. (Taiwan); 8: No. 1, 36-47(Apr 1971).

Four different methods for monitoring preliminary neutron dose at a open-pool reactor seed irradiation facility are described. The methods include a pair of ionization chambers for fast neutron dose and γ dose, sulfur pellets for fast neutron dose, modified Fricke dosimeters for fast neutron and γ dose, and threshold detectors for fast neutron flux monitoring. The principles of each method are discussed and the seed irradiation facility is described. (auth)

2402 POSTIRRADIATION CHROMOSOME ABERRATION FREQUENCY AND THE BIOLOGICAL DOSIMETRY. Zeleny, V. (Inst. of Experimental Biology and Genetics, Prague). Radioisotopy; 11: No. 6, 1157-68(1970). (In Czech).

The possibilities are discussed of biological dosimetry based on estimation of radiation induced chromosome aberrations in peripheral blood cells. The direct quantitative relation between the effect of ionizing radiation and the chromosome aberrations may, in certain situations, provide a valid alternative to physical measurement and enable the estimation of the grade of biological radiation damage. (auth)

Radiation Protection

Refer also to abstract 2414.

2403 CODE OF PRACTICE FOR THE PROTECTION OF PERSONS EXPOSED TO IONISING RADIATIONS IN RESEARCH AND TEACHING. London; Her Majesty's Stationery Office (1968). 64p. Available from Pendragon House, Redwood City, Calif.

A code of Practice to assure the radiation protection of personnel of research establishments using ionizing radiations in Northern Ireland is presented. The Code is based on the standards of the International Commission on Radiological Protection and the Committee on Protection against Ionizing Radiations of the United Kingdom Medical Research Council. General principles of radiation protection are reviewed and guidance for protection when using x-ray equipment and particle accelerators, sealed radiation sources, and unsealed radioactive substances is presented in detail. Emergency procedures for use in case of accidents resulting in exposure of personnel or contamination of surfaces, instructions for the storage of sealed radiation sources and unsealed radioactive materials, and precautions to be taken during the transport of radioactive materials and in the disposal of radioactive waste are summarized. (C.H.)

Safety Procedures

Refer also to abstract 2431.

2404 DESOXYCYTIDINURIA IN PERSONS EXPOSED TO OCCUPATIONAL HAZARD OF CHRONIC RADIATION. Grozdanovic, J.; Vich, Z.; Kratochvil, J.; Truxova, G. (Health Inst. of Uranium Industry, Pribram, Czech.). Cas. Lek. Cesk.; 109: No. 33, 759-60(31 Jul 1970). (In Czech).

CdR-uria values were determined in 10 uranium miners; the control group consisted of 10 employees working on the surface. In active miners, an increase in CdR-uria was ascertained. Oscillopolarographic determination showed an average increase to 156%: while spectrophotometric determination showed an increase to 148%; the average value for the controls was set at 100%. The difference, however, was not statistically significant, owing to a great scatter of values within each group. In the group of active uranium miners, a direct relationship was found between the value of CdR-uria and age for both methods of CdR determination. (NSA of Czech)

Legal Aspects

2405 RESPONSIBILITIES FOR RADIOPHARMACEUTICALS. Pories, Walter J.; Kolenich, James J.; Segal, Alvin S.; (and others) (Cleveland Metropolitan General Hospital). Trans. Amer. Nucl. Soc.; 14: No. 2, 521(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Medicine

Refer also to abstracts 2125 and 2128.

Protective Substances

Refer also to abstracts 2373, 2427, 2442, and 2445.

2406 RADIOPROTECTIVE EFFECT OF LUVATREN. Uray, Z.; Farcasanu, M. (Inst. for Cancer Research, Cluj). Stud. Biophys.; 27: No. 2, 81-4(1971). (In German).

Radioprotective effects of luvatren on average survival time, 30 day survival, and body weight variations of C.B.A.T_6T_6 mice treated with 750R of x rays were studied. Effects on ^{59}Fe incorporation in erythrocytes in another group of mice irradiated with 150 R were also studied. (auth)

2407 RADIOPROTECTIVE EFFECT OF DIFFERENT DOSES OF SODIUM FLUOROACETATE ON MICE IRRADIATED IN A GAS MIXTURE WITH A HIGH OXYGEN CONCENTRATION. Filip, J.; Sikulova, J.; Novak, L.; Hosek, B. (Inst. of Biophysics, Brno). Physiol. Bohemoslov.; 20: No. 3, 269-75(1971).

Male albino strain H mice were used to study changes in the time course of protection afforded by two different doses of FAc (5 mg/kg and 7.5 mg/kg). It was found that raising the dose of FAc did not increase its protective effect, but prolonged the duration of maximum protection up to the third hour after administering FAc. The onset of protection appears in both cases 15 to 60 min after administering FAc. The time course of the development of protection after FAc was also studied in animals irradiated in a high oxygen gas mixture (90% O_2 and 10% N_2). The results showed that inhalation of a high oxygen mixture did not reduce protection involved by the administration of FAc and did not influence its time course. (auth)

2408 BENEFICIAL EFFECTS OF POSTIRRADIATION TREATMENT WITH COBALTOUS CHLORIDE ON THE DEVELOPMENT OF NUCLEAR DAMAGE IN THYMOCYTES, ERYTHROPOIESIS, AND THE SURVIVAL OF MICE. Vittorio, P. V.; Whitfield, J. F. (National Research Council of Canada, Ottawa). Can. J. Physiol. Pharmacol.; 49: 812-18(Sep 1971).

Cobaltous chloride injected subcutaneously into mice immediately after irradiation decreases the number of cells with pyknotic nuclei appearing in the lymphocyte population of the thymus. In vitro studies show that the presence of cobaltous chloride in the incubating medium immediately after irradiation again lowers the subsequent appearance of cells with pyknotic nuclei. A subcutaneous injection of cobaltous chloride into mice immediately after irradiation also increases both erythropoietic recovery (as measured by the incorporation of ^{59}Fe into blood and spleen) and survival. (auth) (Canada)

Radiodiagnosis

Refer also to abstracts 2397, 2405, and 2433.

2409 INHERENT HAZARDS ASSOCIATED WITH SCINTISCANNING PROCEDURES. Strain, William H.; Kolenich, James J.; Rubis, Lorraine J.; (and others) (Cleveland Metropolitan General Hospital). Trans. Amer. Nucl. Soc.; 14: No. 2, 522-3(Oct 1971).

From Joint meeting of the American Nuclear Societv: Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2410 EFFECTIVE DEPTH MEASUREMENT OF SOURCE IN PHANTOM. Notea, A.; Segal, Y.; Pauker, S. (Technion-Israel Inst. of Tech., Haifa, Israel). Trans. Amer. Nucl. Soc.; 14: No. 2, 524-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2411 CLINICAL, PNEUMOENCEPHALOGRAPHIC AND RADIOISOTOPIC STUDY OF NORMAL-PRESSURE COMMUNICATING HYDROCEPHALUS. Tator, C. H.; Murray, S. (Univ. of Toronto, Sunnybrook Hospital, Toronto). Can. Med. Ass. J.; 105: 573-9(18 Sep 1971).

Human serum albumin labelled with iodine-133 or technetium-99m was injected by the lumbar or cisternal route into patients suspected of having communicating hydrocephalus, and scintigrams were performed up to 24 hours after injection. The CSF isotope studies were shown to be a valuable adjunct to clinical examination and pneumoencephalography in the diagnosis of hydrocephalus. This was especially true in suspected cases of "normal"-pressure hydrocephalus when there may be considerable uncertainty as to

which patients with normal pressure and enlarged ventricles will benefit from a shunting procedure. The CSF isotope study provides useful information to the clinician in differentiating patients with symptomatic hydrocephalus from the larger group with dementia, cerebral atrophy and hydrocephalus ex vacuo. (auth) (Canada)

2412 ^{99m}Tc/Na PERTECHNETATE SCANNING OF THE ABDOMEN WITH PARTICULAR REFERENCE TO SMALL BOWEL PATHOLOGY. Duszynski, Diana O.; Jewett, Theodore C.; Allen, James E. (Children's Hospital, Buffalo). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 113: No. 2, 258-62(Oct 1971).

Increased uptake of the ^{99m}Tc/Na pertechnetate in gastric mucosa of Meckel's diverticula and in both acute and chronically obstructed small bowel loops was successfully demonstrated by the use of this isotope in abdominal scanning. Initial scans of two patients showed decreased uptake in such fluid-filled structures as abscess and an interior meningocele. Since some of these lesions are not readily diagnosed by conventional contrast roentgenographic studies, ^{99m}Tc/Na pertechnetate abdominal scanning can be of value in demonstrating such pathology. (auth)

Radiotherapy

Refer also to abstract 2421.

Radiation Effects on Animals

Refer also to abstract 2376.

2413 RESTORATIVE EFFICIENCY OF YEAST RNA ON IRRADIATED HEMOPOIETIC STEM CELLS. Duplan, J. F.; Ekert, B.; Legrand, E.; Guillemain, B. (Institut du Radium, Paris). Atomkernenergie; 18: No. 2, 97-100(1971).

The reported experiments demonstrate that yeast RNA which is known to restore in vitro bacteria and cultured cells and in vivo whole body irradiated animals acts as well on the hemopoietic stem cells. Ribosomal RNA and tRNA display the same efficiency as total RNA. The mechanism of action has been studied in vivo by the spleen colony assay. Several hypotheses which could explain the therapeutic effect of RNA have been discussed among which a stimulation of mitotic activity and a reduction of the differentiation rate have been rejected. It seems more likely that RNA enables the cells to repair some lesions that would otherwise have been lethal. (auth)

Invertebrates

Refer also to abstract 2437.

Vertebrates

Refer also to abstracts 2375, 2384, and 2406–2408.

2414 (FRNC-TH-97) QUANTITY OF BONE MARROW WHICH MUST BE PROTECTED IN ORDER TO ENSURE THE SURVIVAL OF PIGS IRRADIATED WITH A LETHAL DOSE. Maas, Jean (Paris Univ., Orsay (France). Faculte des Sciences). 1971. 53p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Survival after a lethal dose of radiation occurs only if sufficient bone marrow is protected or transfused. It is important to discover whether or not an irradiated animal can ensure the hemopoietic repopulation of its tissues. These problems were studied with swine which have a girth, weight, food intake, and radiosensitivity, similar to man. The distribution of bone marrow was studied in swine ^{60}Co γ irradiated with a dose of 890 rads; ^{59}Fe and ^{75}Se tracers were used. The degree of protection afforded by Pb screens was studied with different bones using different thickness screens and different extents of protection. It was possible in this way to calculate the number of surviving protected cells, and to evaluate the quantity of protected marrow necessary to ensure the survival of these animals. (France)

2415 (NVO-269-12) EFFECTS OF TRITIATED WATER ON THE EMBRYONIC DEVELOPMENT OF THE THREE-SPINE STICKLEBACK, GASTEROSTEUS ACULEATUS LINNAEUS. Walden, Stanley J. (Washington Univ., Seattle. Lab. of Radiation Ecology). 10 May 1971. Contract AT(26-1)-269. 13p. (CONF-710501-37). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

Nine pairs of stickleback (Gasterosteus aculeatus Linnaeus) were artificially crossed in the laboratory. Fertilized eggs were incubated to hatching in tritium concentrations of 0.5, 1.0, and 2.0 mCi/ml of filtered lake water within closed systems. A significant reduction in mean eye diameter was observed for tritiated lots over corresponding controls at concentrations of 1.0 and 2.0 mCi/ml. No other obvious morphological anomalies were seen. Successful incubation of eggs within a closed system appeared to depend upon the percentage of early mortality of the eggs and the resulting bacterial build-up within the system. Where early egg mortality was minimized, hatching was most successful. (auth)

2416 (NYO-3621-11) NUCLEAR METABOLISM OF DNA AND RNA AND THE SITES OF RADIATION SENSITIVITY. Final Report. Abrams, Richard (Pittsburgh Univ., Pa. Dept. of Biochemistry). 31 Dec 1970. Contract AT(30-1)-3621. 34p. Dep. NTIS.

Results are reported from studies on the effects on x radiation on DNA synthesis in cultured rabbit kidney cells. Histones labeled with ^{14}C- or tritium-labeled L-arginine or L-lysine were used as tracers and methods used for their preparation are described. Results are also reported from studies on protein synthesis in cultured Ehrlich's ascites cells and the relationship between virus infections and the activity of oxidoreductases and transferases in HeLa cell cultures. (C.H.)

2417 (ORO-3599-6) CHANGES IN THE RETINA AND VISUAL PATHWAY FOLLOWING DOSES OF X-RAYS AT THERAPEUTIC LEVELS. Dawson, William W.; Perez, Jose M. (Florida Univ., Gainesville. Coll. of Medicine). [1971]. Contract AT(40-1)-3599. 42p. Dep. NTIS.

Electrical measures of visual function were made at several points in the visual pathway of cats before and up to 64 hours after the delivery of 4,080 roentgens to one orbit. The contralateral eye was control. Results indicate that the ERG b-wave is the most highly sensitive signal to ionizing radiation. Responses relating to photopic function and transmission of information from the eye to the central nervous system was effected much less rapidly. Small changes of intraocular temperature indicate increased blood-flow in the tissue of the experimental eye. The major change in blood flow occurred 8 hours after exposure and then returned toward normal. There was no demonstrable change in the vascular pattern of the irradiated fundus. Histology of the experimental eyes showed early damage to the receptor layer with edema in several retinal layers; however, these findings were local with islands of apparently normal retina remaining at 64 hours after exposure. (auth)

2418 (USC-113-P-18-X-1) AN INVESTIGATION OF ACUTE EFFECTS OF RADIATION ON SYNAPTIC MECHANISMS. Final Report. Carregal, Enrique J. A. (University of Southern California, Los Angeles. Dept. of Surgery (Neurological)). [1970]. Contract AT(11-1)-113. 27p. Dep. NTIS.

The acute effects of ionizing radiation on spinal monosynaptic pathways were studied in cats. Radiation doses as low as 65 R have a detectable effect on the thresholds of the presynaptic terminals and the postsynaptic elements in the spinal cord; thresholds for electrical stimulation increase, while the threshold for transynaptic activation of motoneurons decreases. However, changes which could be interpreted as having a meaningful influence on the integrative function of monosynaptic reflexes are not obtained until doses of 25,000 to 35,000 R are reached. Between 45,000 and 65,000 R monosynaptic responses are abolished. At the ultrastructural level no effects are detected until doses of 10,000 to 16,000 R are reached. At these doses alterations in the size of synaptic vesicles are noted. Beyond 35,000 R, ionizing radiation seems to have a particularly damaging effect upon membranes of large structures, mitochondria, endoplasmic reticulum, and synaptic vesicles. (auth)

2419 COMPARATIVE LEUKEMIA RESEARCH, 1969. Proceedings of the IVth International Symposium, Cherry Hill, N. J., September 21–25, 1969. Dutcher, Ray M. (ed.). Bibliotheca Haematologica, No. 36. Basel; S. Karger AG (1970). 820p. $31.50. (CONF-690983).

Separate abstracts were prepared on six papers. Various aspects of leukemia research, with emphasis on the role of viruses in leukemia induction in experimental animals, are discussed in 91 additional papers. (C.H.)

For abstracts of individual papers see: 2420–2425.

2420 IMMUNIZATION BY THE RADIATION LEUKEMIA VIRUS. Haran-Ghera, N. (Weizmann Inst. of Science, Rehovoth, Israel). Bibl. Haematol.; No. 36, 261-6(1970).

From fourth international symposium on comparative leukemia research; Cherry Hill, N. J. (21 Sep 1969).

C57BL/6 mice were rendered resistant to further isotransplantation of leukemic cells by injecting different dilutions of the virus isolated from mouse radioinduced lymphoid tumors directly into the thymus. Only those virus dilutions which retained leukemogenic activity were found to have an immunizing effect. Im-

munization was noted 15 days after inoculating the radiation leukemia virus into the thymus, and removal of the thymus thereafter did not diminish host resistance. Immunization was also tested for preventing lymphatic leukemia induction. A reduction to an 18% lymphoma incidence was obtained in immunized mice, compared to an 85% rate in non-immunized treated mice. (auth)

2421 CURRENT STUDIES ON THE THERAPY OF EXPERIMENTAL LEUKEMIA. Chirigos, M. A. (National Cancer Inst., Bethesda, Md.). Bibl. Haematol.; No. 36, 278-92(1970).

From fourth international symposium on comparative leukemia research; Cherry Hill, N. J. (21 Sep 1969).

Methods for controlling oncogenic viruses and the disease they induce in mice fall into three categories: chemotherapy, immunological, and stimulation of natural host resistance mechanisms. Chemotherapy, although not selective, effectively limits viral replication by eliminating neoplastic cells as well as cells replicating virus. Active or passive immunization, although effective prophylactically, suffers from the disadvantage that the effectiveness is lessened once infection has become established. Stimulation of natural host resistance mechanisms presents a potentially more realistic approach, particularly in view of the successes achieved with interferon. The logical approach then lies in the judicial use of effective drugs in conjunction with host immune factors, which may be enhanced by either internal or external means. Whole-body x irradiation at doses of 200 to 400 R resulted in bone marrow suppression and regeneration of the reticuloendothelial system, and a marked decrease in virus content of the liver and spleen. This effect persisted for about two weeks following irradiation. (C.H.)

2422 EXPERIMENTAL INDUCTION OF PORCINE LEUKEMIA. Howard, E. B. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Bibl. Haemotol.; No. 36, 430-9(1970).

From fourth international symposium on comparative leukemia research; Cherry Hill, N. J. (21 Sep 1969).

Results of a study on the induction of leukemia in miniature swine following the chronic ingestion of ^{90}Sr indicated that the most deleterious effect of chronic exposure to ^{90}Sr, which resulted in a uniform skeletal deposition of this radionuclide, is the alteration in normal hematopoiesis with resulting hematopoietic neoplasia as the end result. Several factors which may be significant in the leukemogenic process, such as defective immunologic response and altered leukocyte function, have been identified in these animals following ^{90}Sr exposure. This animal system may provide an experimental model to study the differences and similarities of myeloid metaplasia and myelogeneous leukemia, to determine if they are stages of the same disease process. Age related effects of ^{90}Sr exposure may be evaluated, since lymphoma developed at lower exposure levels and with two exceptions in offspring of animals exposed to ^{90}Sr. (auth)

2423 VIRUS ASSOCIATION WITH ^{90}Sr INDUCED LEUKEMIA OF MINIATURE SWINE. Frazier, M. E.; Ushijima, R. N.; Howard, E. B. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Bibl. Haematol.; No. 36, 440-5(1970).

From fourth international symposium on comparative leukemia research; Cherry Hill, N. J. (21 Sep 1969).

An adenovirus was isolated from a miniature swine with ^{90}Sr radioinduced myelogenous leukemia. In addition, C type particles were seen in several preparations from this and other leukemic swine. It was concluded that a mixture of viruses was present in these animals at the time of sacrifice. These agents could well be passenger viruses present in a viremic state as a result of the animals debilitated condition. However, these viruses may play a direct or indirect role in the radiation induced leukemogenesis of the miniature swine. (auth)

2424 SIGNIFICANCE OF VIRUS PARTICLES OBSERVED IN SPONTANEOUS AND INDUCED TUMORS OF THE SYRIAN HAMSTER. Stenback, W. A.; Van Hoosier, G. L. Jr.; Ferguson, Dee Boren; Trentin, J. J. (Baylor Coll., Houston, Tex.). Bibl. Haematol.; No. 36, 559-65(1970).

From fourth international symposium on comparative leukemia research; Cherry Hill, N. J. (21 Sep 1969).

Among the special characteristics which make the Syrian hamster a particularly valuable species for experimental oncology are the relatively low incidences of spontaneous tumors and enzootic viruses. Of 407 spontaneous hamster tumors reported in the literature 35% belonged to the leukemia-lymphoma class. In one colony the incidence of spontaneous tumors was 0.5% during a 5-year period with three out of the total of eight being lymphomas. All lymphomas carried in our colony contain a type C virus which has characteristics common to known oncogenic RNA viruses and antigenic cross-reactivity with at least some, but preliminary tests of oncogenic potential of this agent have been inconclusive. The type C particle as well as the Bernhard type particle are endemic in the colony. In addition, type A particles were found in a tumor which arose following attempts to activate type C virus by x irradiation. The tumor also contained budding type C and Bernhard particles. The hamster apparently harbors several viruses detectable only by electron microscopy. (auth)

2425 C-TYPE VIRUS PARTICLES IN RAT TUMORS. Chopra, H. C.; Dutcher, R. M. (Charles Pfizer and Co., Inc., Maywood, N. J. Univ. of Pennsylvania, Kennett Square, Pa.). Bibl. Haematol.; No. 36, 584-92(1970).

From fourth international symposium on comparative leukemia research; Cherry Hill, N. J. (21 Sep 1969).

Spontaneous and x radioinduced transplantable rat mammary tumors and leukemias were investigated for virus particles. Electron microscopic study of the transplanted rat mammary tumors revealed the presence of C-type particles. The primary tumors failed to show the presence of such particles. Similarly, a large amount of virus was detected in a mammosomatotropic tumor and its variant which metastasized to the ovary. Several rat leukemias also revealed the presence of C-type structures but the size and configuration of particles detected in lymphocytic leukemia were different from the monocytic and myelogenous leukemias. (auth)

2426 THERMAL AND RADIATION EFFECTS OF ^{238}Pu FUEL CAPSULES ON DOGS AND PRIMATES. Huffman, F. N. (Thermo Electron Corp., Waltham, Mass.); Molokhia, F. A.; Norman, J. C. Trans. Amer. Nucl. Soc.; 14: No. 2, 510-11(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2427 EFFECT OF CAROTENOID PIGMENTS ON SUBLETHAL RADIATION INJURY IN RATS. Bamji, Mahtab S. (Nutrition Research Labs., Hyderabad, India). Indian J. Exp. Biol.; 7: No. 3, 178-80(Jul 1969).

Growing male albino rats subjected to 360 R whole body radiation with 250 KVP x-rays showed marked leucopenia, diminution in spleen weight and nucleic acid content. Pretreatment with carotenoid pigments, viz. β-carotene, lycopene, or crocetin, had no effect on the leucocyte count or spleen weight. However, β-carotene and crocetin partially corrected the nucleic acid levels of the spleen suggesting that some carotenoid pigments might be able to offer marginal protection against radiation injury, but these pigments cannot be regarded as important radio protectors. (auth)

2428 RELATION BETWEEN THE DISTURBANCE OF THE MOTOR FUNCTION OF THE ALIMENTARY TRACT AND THE QUANTITATIVE VARIATIONS OF SEROTONIN AND SULFHYDRIL GROUPS IN DIFFERENT PERIODS OF RADIO INJURY. Dovlatyan, S. V.; Yaralova, G. A. Biol. Zh. Arm.; 24: No. 1, 112-13 (Jan 1971). (In Russian).

The quantity of serotonin and SH-groups in the intestinal tissue of rats was determined 7 to 8 days and 17 to 18 days after the rats were subjected to ionizing radiation. The serotonin content was lowered about 30% by the radiation, and the sulfhydryl content was lowered 38%. It was concluded that definite parallels exist between these chemical changes and deterioration of the motor function of the intestine as a result of the effects of ionizing radiation. (K.S.W.)

2429 GROWTH AND SENESCENCE OF THE BONE MARROW STEM CELL POOL IN RFM/UN MICE. Davis, M. L.; Upton, A. C.; Satterfield, L. C. (Oak Ridge National Lab., Tenn.). Proc. Soc. Exp. Biol. Med.; 137: No. 4, 1452-8(Sep 1971).

The exogenous spleen colony assay procedure has been used in RF mice to: measure growth and senescence of the bone marrow stem cell compartment, compare the radiation sensitivity and recovery capacity of marrow stem cell compartments in fetal vs young adult mice, and determine residual radiation injury to tissues giving rise to hemopoietic progenitor cells in mice irradiated during fetal development or as young adults. The bone marrow of normal RF mice reached maximum hemopoiesis potential (20.9 CFU/10^5 nucleated marrow cells) within the first 3 weeks of postnatal life. This value was maintained through the first half of the mouse life. Thereafter, a progressive decline of marrow CFU potential was associated with increasing age of the animals. The stem cell pool in fetal mice appears to be less radiation sensitive and more capable of early recovery from radiation injury than that of 10- to 21-week-old young adults. Senescence of bone marrow stem cell function was accentuated in mice exposed to radiation either during fetal development or as young adults. (auth)

2430 CHANGES OF THE CORTICOSTEROID CONTENT IN ADRENAL GLANDS AND BLOOD OF IRRADIATED AND COMBINED INJURED RATS. Messerschmidt, O.; Seydewitz, V.; Flemming, K.; Geierhaas, B. (Univ., Freiburg i. B.). Atomkernenergie; 18: No. 2, 115-19(1971). (In German).

The corticosteroid content was determined by the fluorometric

method according to MONCLOA. Rats were inflicted with whole body irradiations of 750 R or with combined injuries (that means 2 open skin wounds were set at different intervals before or after irradiation). A biphasic increase of the corticosteroid values is found after irradiation. The first increase appears within the first 6 hours, the second one on the 2nd and 3rd day after irradiation. The changes of the corticosteroid values are much more complex after the different combined injuries. If irradiated animals are inflicted with open wounds, the increase of the corticosteroid content is considerably higher in comparison with only irradiated animals, and these high values can be observed during a longer period. If wounds are set before irradiation, however, no significant differences were found in comparison with irradiation only. The causes for the changes of the corticosteroid content are discussed. (auth)

Man

Refer also to abstracts 2402 and 2404.

2431 ORIENTED HAEMOLYSIS OF ERYTHROCYTES IN URANIUM ORE MINERS. Nosek, J. (Health Inst. of Uranium Industry, Pribram, Czech.). Cesk. Fysiol.; 18: No. 5-6, 449-53 (1969). (In Czech).

Suspensions of washed-out erythrocytes were studied by oriented haemolysis in uranium ore miners. No significant difference from controls was found in the number of test tubes with haemolysis and in the number of haemolytic bands. Differences were observed only in the average length of the haemolytic bands and their most frequent location. In uranium ore miners, the occurrence of long haemolytic bands and their location at the end of the row of test tubes was more frequent; the reason for this has not yet been found These changes, however, could also be artificially induced by addition of uranyl and lead salts to the erythrocyte suspension. (NSA of Czech.)

2432 REACTIVITY CHANGES AFTER IRRADIATION. Jansa, P.; Kucera, M.; Zemanek, R. (Research Inst. of Pediatrics, Brno). Cesk. Radiol.; 24: No. 5, 202-7(Sep 1970). (In Czech).

The nasopharynx of children was irradiated with a dose of 300 R and after repeated examinations the results were compared with controls. The process of cellularization was observed in radio-induced inflammations and levels of alkaline phosphatase in granulocytes were determined. Four weeks after irradiation an increase in activity of alkaline phosphatase was observed. This was accompanied by a weakening and retardation of the onset of the second cellular sequence of the induced inflammatory reaction, i.e., of large mononuclear formations. (NSA of Czech)

2433 ANGIOGRAPHIC DEMONSTRATION OF RADIATION COLITIS. Sprayregen, Seymour; Goltzer, Philip (Montefiore Hospital and Medical Center, Bronx, N. Y.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 113: No. 2, 335-7(Oct 1971).

A case of radioinduced proctosigmoiditis following therapy diagnosed by means of inferior mesenteric arteriography is reported. The arteriographic findings were correlated histologically with an inflammatory process accompanied by ulceration and telangiectasia. (auth)

2434 CHANGED DISTRIBUTION OF PLASMATIC LIPOPROTEINS AND CHOLESTEROL AS A BASIS FOR THE INDIVIDUAL TOLERANCE TEST. Roth, Karel; Adamek, Milos (ZUNZ Uranium Industry, Pribram, Czech.). Radioisotopy; 11: No. 6, 1145-56(1970). (In Czech).

Changes in the content of cholesterol and lipoproteins in the blood plasma of uranium miners were determined in relation to the Rn concentration of inhaled air. The changes induced by the presence of ionizing radiations from Rn and its decay products dissolved in the blood diminished with time. It was concluded that this change was related to adaptation mechanisms. (C.H.)

2435 RESULTS OF SOME HEMATOLOGICAL EXAMINATIONS IN URANIUM MINERS. Kriklava, Josef (ZUNZ Uranium Industry, Pribram, Czech.). Radioisotopy; 11: No. 6, 1169-85 (1970). (In Czech).

Blood picture examinations in 3642 uranium miners divided into groups according to the duration of working exposure were evaluated in comparison to 379 control men. The mean values of the indexes (leukocyte count, erythrocyte count, and hemoglobin content) differed significantly from the controls in relation to the duration of working time, but none of the indexes were outside physiological limits. The count of thrombocytes decreased significantly in 294 exposed persons in relation to 159 controls. It was concluded that small chronic radiation doses changed some indexes of blood components but did not cause damage of the organism manifest by clinical changes. The changes coincided with physiological adaptation of the organism. (auth)

2436 USE OF SOME METABOLIC TESTS AS AN INDICATOR OF RADIATION RISK IN URANIUM MINERS. Vich, Z.; Grozdanovic, J.; Novosad, F. (ZUNZ Uranium Industry, Pribram, Czech.). Radioisotopy; 11: No. 6, 1187-1202(1970). (In Czech).

The urinary excretion of deoxycytidine was examined in uranium miners and in other uranium workers and a slight increase in miners was found. The content of cystine in the fingernails of uranium miners was found to be decreased. Increased activity of the pentose phosphate metabolic pathway, decreased activity of the glucose 6-phosphate-dehydrogenase and increased activity of the glutathione reductase in erythrocytes were found in uranium miners. These results suggested a changed functional status of metabolism in erythrocyte in uranium miners. (auth)

Radiation Effects on Plants

Refer also to abstracts 1866 and 2401.

2437 (NP-19016) APPLICATION OF ATOMIC ENERGY IN AGRICULTURE. Annual Report, 1970. (Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen (Netherlands)). 1971. 92p. Dep. NTIS (U. S. Sales Only).

Work carried out during 1970 at the Association's Institute in Wageningen and at other institutes in Belgium, Germany, Italy, and the Netherlands is reported under the following headings: mutation breeding, methodology; mutation breeding, collaboration; radiogenetics, ontogenetic factors; radiogenetics, physical and chemical factors; related genetic studies; related in vitro studies; preservation of food by means of radiation; induction of male sterility in insects by means of radiation; the behavior of specific nuclides in plants and soil; and related physical studies. (auth)

2438 EFFECT OF CELL CONCENTRATION ON LIQUID HOLDING RECOVERY OF SACCHAROMYCES AFTER UV-IRRADIATION. Lochmann, E.-R.; Umlauf, C. (Freie Univ., Berlin). Stud. Biophys.; 27: No. 2, 85-90(1971). (In German).

Liquid holding recovery of Saccharomyces cells after uv irradiation is lower for a cell concentration of 5×10^3 than for 5×10^6 cells/ml. The low dark reactivation (DR) rate with 5×10^3 cells/ml increases if supernatant buffer is used in which the cells were suspended for several hours. The effect of such supernatants cannot be destroyed by uv irradiation or heat. A stimulated DR-rate can also be obtained if a very low concentrated culture medium (normal medium diluted 1 : 1000) is used for liquid holding recovery instead of buffer alone. (auth)

2439 RADIATION BIOPHYSICAL INVESTIGATIONS OF ARABIDOPSIS THALIANA. V. EXPERIMENTS WITH X-RAYS AND FAST NEUTRONS. Ivanov, V. I.; Ginter, T. N.; Sanina, A. V.; (and others) (Inst. of Medical Radiology, Obninsk, USSR. Institutes fuer Biophysik, Rossendorf, Ger.). Stud. Biophys.; 27: No. 2, 131-7(1971). (In German).

Air-dry seeds of A. thaliana were irradiated with x-rays (average LET about 1.6 keV/μm, dose rate about 6 krad/hr, doses ranging from 10 to 40 krad) and Be (d,n) C neutrons (average LET about 30 keV/μm, dose rate about 6 krad/hr, doses ranging from 5.2 to 20.8 krad). About 230 seeds were sown per dose level of each kind of rays. Twelve different characters were scored, representing the effects of irradiation on plant survival, growth, development, seed setting and mutation rate. It was found that neutron irradiation exerted much greater effects than x-rays: with neutrons no survivors were observed at the dose of 20.8 krad, while with the double doses of x-rays a number of plant characters still did not differ essentially from unirradiated control level. Due to the latter circumstance, a pooled value of D_{50} of x- and gamma-rays (based on a number of previous experiments with higher doses) was used for a rough estimation of RBE of neutrons vs. x- and gamma-rays. The obtained RBE values for the plant responses to irradiation varied within rather narrow limits (from about 6 to about 11). This indicates that the difference in effectiveness of neutrons relative to x- and gamma-ray originates at the earlier stages of radiation injury, but not at the later ones, since the latter differ very much for the various plant responses to irradiation. (auth)

2440 EFFECT OF GAMMA-RADIATION ON CALLUS GROWTH OF PHYLLOXERA GALL AND NORMAL GRAPE STEM TISSUES IN CULTURE. Arya, H. C.; Hildebrandt, A. C. (Univ. of Wisconsin, Madison). Indian J. Exp. Biol.; 7: No. 3, 158-62(Jul 1969).

The responses of callus tissues of normal grape stem and Phylloxera vastatrix Planch induced gall exposed to 10,000 R gamma rays from cobalt-60 source have been studied. Growth of normal callus was inhibited considerably while gall callus grew well after irradiation. The growth of both tissues was

highest when smaller tissue transplants (200 mg) were irradiated and grown on non-irradiated medium, suggesting that smaller tissue transplants are more radioresistant as compared to larger ones. In case of normal tissues the period of resistance was 1 week while in gall tissue it extended up to 3 weeks. Irradiated normal tissues grew well on highly acidic media (pH 3.5–5.0) while gall tissues grew well in slightly acidic media (pH 5.0–6.0). Non-irradiated tissues grew well on irradiated medium indicating that radiolyzed products in the medium did not inhibit growth. (auth)

2441 INITIAL PROTRUSION OF A LEAF PRIMORDIUM CAN FORM WITHOUT CONCURRENT PERICLINAL CELL DIVISIONS. Foard, Donald E. (Oak Ridge National Lab., Tenn.). Can. J. Bot.; 49: 1601-3(Sep 1971).

The view that periclinal cell divisions cause the initial protrusion of a leaf primordium may be tested by using ionizing radiation to prevent cell divisions without preventing growth. After receiving 800 krad of gamma rays, wheat grains containing embryos with three leaf primordia produce seedlings in which a fourth protrusion of the shoot apex forms unaccompanied by cell divisions. This protrusion without periclinal divisions occurs in the same phyllotactic position as that of the fourth leaf primordium in which periclinal divisions occur. In addition to proper phyllotactic position, the protrusion without cell divisions is formed by the outermost cell layer, as is the initial protrusion of a typical leaf primordium of wheat; moreover, the initial number of cells involved is the same in both kinds of protrusions. Therefore the fourth protrusion in seedlings from irradiated grain is interpreted as the initial protrusion of a leaf primordium that formed without periclinal cell divisions. Measured along the axis of greatest extension, the protrusions without cell divisions represent about a four- to eight-fold increase over the anticlinal dimension of the surface-cell layer in the embryo. These protrusions do not develop further. The absence of cell divisions limits the extent of primordial growth, but does not prevent its inception. Periclinal cell divisions do not cause the initial protrusion of a leaf primordium. (auth) (Canada)

2442 USE OF MIXTURE OF CHEMICAL PROTECTORS AGAINST X-RAY DAMAGE IN PLANTS. Kaul, B. L. (Max-Planck-Institut fuer Zuechtungsforschung, Cologne). Indian J. Exp. Biol.; 9: No. 1, 69-71(Jan 1971).

Radioprotective ability of DMSO (dimethylsulphoxide), cystein and cysteamine when applied alone or in combination with each other was determined using lateral roots of Vicia faba and seeds of diploid barley. The level of protection as offered by DMSO alone cound not be increased when either cystein or cysteamine was mixed with DMSO. It is suggested that for a mixture to be more efficient as radioprotective agent it may be essential to choose among such chemicals which possess different modes of action from one another. (auth)

2443 BIOLOGIC PROPERTIES OF MOULDS FROM URANIUM MINES AND THEIR RELATIONSHIP TO SOME DISEASES IN MAN. Adamek, M.; Roth, K. (Division of Radiotoxicology, Pribram, Czech.). Radioisotopy; 11: No. 6, 1121-43(1970). (In Czech).

Several species of fungi (Aspergillus, Penicillium, and Tricophyton) were found growing in a uranium mine that had been worked for over one-hundred years. A study was made to try to determine the effects of low levels of ionizing radiations in the environment on the morphology and taxonomy of the fungi. Uranium ions were found to stimulate growth of the fungi under laboratory conditions. The possible relation of fungi to the incidence of respiratory diseases in uranium miners was investigated in animal studies. Aspergillus conidia survived following inhalation, were transported through the blood and lymph systems, and had a pathological effect when deposited in pulmonary tissues. (C.H.)

Radiation Effects on Microorganisms

Refer also to abstracts 1866, 2362, and 2447.

2444 RADIATION SENSITIVITY OF FISH MICROFLORA. Lewis, N. F.; Alur, M. D.; Kumta, U. S. (Bhabha Atomic Research Centre, Trombay, India). Indian J. Exp. Biol.; 9: No. 1, 45-7(Jan 1971).

The gram-negative organisms, viz. Aeromonas hydrophila, Proteus vulgaris, a Pseudomonas sp. and an Achromobacter sp., isolated from spoilt fish which were found to rapidly ferment carbohydrates, liquefy gelatin and produce H_2S and indole, possessed exponential radiosurvival curves when irradiated in buffer, with D_{10} values of 7.0, 6.7, 4.5, and 9.4 Krad respectively. On the other hand, the radio-survival curves of three gram-positive cocci, viz. Micrococcus luteus, Micrococcus radiodurans and an unidentified Micrococcus sp., which did not produce H_2S or indole and has no effect on carbohydrates, were punctuated by an initial shoulder; the unidentified Micrococcus sp. was more radioresistant than M. radiodurans by several orders of magnitude. P. vulgaris, A. hydrophila and the Pseudomonas sp., found primarily responsible for putrid odors in fish, were more resistant when irradiated in 10% fish homogenate as compared with irradiation in buffer, their D_{10} values increasing from about 2- to 4-fold. (auth)

2445 RADIOSENSITIZATION OF E. COLI CELLS BY NON-TOXIC THYMINE ANALOGUES. Muresian, T.; Mustea, I.; Uray, Z.; Kiricuta, I. (Oncological Inst., Cluj). Stud. Biophys.; 27: No. 2, 97-101(1971).

The radiosensitizing effect of two new analogues of thymine, derivatives of the 5-amino-6-hydroxi thymine, were tested on E. coli B, cultures in synthetic medium. The substances presented the property of being non-toxic for Escherichia coli, and as a result of the tests performed, remarkable radiosensitizing effects were rendered evident. On the basis of D_0, the modifying factor of the slope was computed and the value 1.45 resulted for the treated cultures, and a value of 0.67 for the dose modifying factor of the control cultures. (auth)

2446 INCREASING THE BIOCHEMICAL ACTIVITY OF LACTIC ACID BACTERIA BY MUTAGENIC FACTORS. Bannikova, L. A.; Pyatnitsyna, I. N. (All-Union Research Inst. of the Dairy Industry, Moscow). pp 123 of XVIII International Dairy Congress. Vol. 1E. Sydney; International Dairy Congress Editorial and Technical Committee (1970).

From eighteenth international dairy congress; Sydney, Australia (12 Oct 1970). See CONF-701059-(Vol.1E).

The possibility of enhancing the acid production of Streptococcus lactis by uv irradiation, ethylenimine and combinations of the two was explored. Survival time of 3 strains of Str. lactis was decreased uniformly by increasing radiation dose or uv-mutagen concentration, but decreased with different sensitivities to mutagens. Plus-variants with higher acid producing properties were created by the action of either uv rays or uv-ethylenimine combinations. Several stable starters were selected consisting of mutants which showed high activity and good organoleptic properties. They were found effective in making fermented milk products. (Australia)

Radiosterilization and Radiopreservation

Refer also to abstracts 2437 and 2444.

2447 SPOILAGE POTENTIAL OF PREDOMINANT ORGANISMS AND RADIATION SURVIVORS IN FISHERY PRODUCTS. Alur, M. D.; Lewis, N. F.; Kumta, U. S. (Bhabha Atomic Research Centre, Trombay, India). Indian J. Exp. Biol.; 9: No. 1, 48-52(Jan 1971).

Representative microorganisms of four microbial species, viz., Proteus vulgaris, Pseudomonas sp., Achromobacter sp., and Aeromonas hydrophila, isolated from spoilt fish, and three Micrococci, viz. Micrococcus luteus, Micrococcus (unidentified) and Micrococcus radiodurans, the former two isolated from irradiated fish, were studied for their spoilage potential at 0°, 10°, and 30°C, in terms of their ability to produce trimethylamine (TMA) and volatile nitrogenous compounds (TVB), and reduce organoleptic attributes (OS) of fish homogenates into which they were individually seeded, prior to incubation. P. vulgaris and the Pseudomonas sp. developed putrid odors and produced large amounts of TMA and TVB as compared to the Achromobacter sp. and A. hydrophila which developed unpleasant sweetish odors and produced moderate amounts of TMA and TVB compounds, and the three Micrococcus sp. which elaborated insignificant quantities of TMA and TVB compounds, and developed only stale odors, during terminal spoilage at 0°, 10°, and 30°C. (auth)

2448 RADIOSTERILIZATION OF MEDICAL PRODUCTS. III. Uhlig, K. Isotopenpraxis; 7: No. 6, 203-7(Jun 1971). (In German).

Industrial application of radiosterilization of medical products is a further extension of the peaceful uses of atomic energy. The qualitative advantages of radiosterilization outlined include: the bactericidal effect of ionizing radiation; irradiation of packaged products, using appropriate packaging material; utilization of new materials, especially plastics, that could not previously be used in conventional sterilization methods; and the realization of automated technological procedures for continuous production with high efficiency. The use of ^{137}Cs γ sources in large radiosterilization installations is evaluated with respect to economy and efficiency. International guidelines for radiosterilization of medical products are discussed. (H.B.G.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 2184.

Corrosion and Erosion

Refer also to abstract 2056, 3154, and 3156.

2449 (EUR-4677) KINETICS OF THE HYDRIDATION IN TERPHENYL, OUTSIDE THE BATTERY, OF EXPLOSIVE WELDED Zr–2.5 PERCENT Nb/CARBON STEEL JOINTS. Coen, F.; Henry, B.; Huber, B. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 18 Feb 1971. 36p. (In French). Dep. NTIS (U. S. Sales Only). EUR FF 5.60.

The hydriding rate in terphenyl of explosive welded Zr-2.5% Nb/carbon steel joints, designed for pressure tubes of heavy-water moderated reactors, was evaluated experimentally. Both longitudinal samples cut in the joints and whole joints were exposed to terphenyl in an autoclave at 360 and 400°C, with different exposure times. The total quantity and the distribution of hydrogen introduced in the zirconium part through the steel part of the joints were measured by a subsequent analysis of the zirconium part. The hydriding rate for these short test pieces was found to be 0.45 $\mu g/cm^2/hr$ at 360°C and 2.3 $\mu g/cm^2/hr$ at 400°C (the transverse section of zirconium being taken as reference). A theoretical analysis of the phenomenon is presented in order to extrapolate the results to the real case of the long zirconium tube, in the temperature range of practical interest. The results of this analysis indicate that the hydrogen saturation of the long zirconium tube near the zirconium–steel weld, would be reached in 300 hr at 400°C, 17,000 hr at 360°C, and 400,000 hr at 300°C. (auth)

2450 (INR–1286) X-RAY AND DERIVATOGRAPHIC STUDIES OF TEMPERATURE CHANGES AND OXIDATION PROCESS OF PLASMA-SPRAY POWDERS. Gorski, Ludwik; Hammer, Wieslaw (Institute of Nuclear Research, Warsaw (Poland)). 1971. 25p. (In Polish). Dep. NTIS (U. S. Sales Only).

Powder specimens of tungsten carbides with small amounts of cobalt added were deposited on steels and Ni–Cr alloys and annealed in heating equipment to the temperature 1200°C. The course of the oxidation process, with the detailed stages of it, was observed. The products of processing were studied by x-ray diffraction analysis to determine the crystalline oxide modifications and to estimate the contents of it in samples from the intensities of diffraction lines. This work was directed to the problem of finding a suitable composition for use as protective coatings deposited by plasma flame spraying. (auth)

2451 (NYO–4117-5) DEVELOPMENT OF HIGH TEMPERATURE ROLLING BEARINGS FOR OPERATION IN LIQUID SODIUM. Quarterly Progress Report No. 4, April 1, 1971–June 30, 1971. Jamison, W. E. (SKF Industries, Inc., King of Prussia, Pa. Research Lab.). Contract AT(30-1)-4117. 16p. Dep. NTIS.

Work devoted to development of equipment and methods for use in investigation of rolling bearing performance in liquid sodium at 1200°F is summarized. Materials to be tested are NM100 tool steel and Udimet 700. (J.R.D.)

2452 FURTHER STUDIES DEFINING THE AQUEOUS CORROSION PERFORMANCE OF A ZIRCONIUM–NIOBIUM–COPPER ALLOY. Kass, Stanley (Bettis Atomic Power Lab. West Mifflin, Pa.). Corrosion; 27: No. 10, 443-8(Oct 1971).

Additional experiments were performed to further explore the influence of heat treatment upon the corrosion performance of a Zr–2.5% Nb–0.5% Cu alloy. Heat treating in the alpha-plus-beta region followed by rapid cooling to room temperature and a subsequent anneal at 1000°F yields a material with high corrosion resistance in 600 and 680°F water. The corrosion resistance increases with increasing cooling rate from the $\alpha + \beta$ region prior to the α anneal. On the other hand, hydrogen pickup was found to increase with increasing cooling rate. The hydrogen absorption rate of the material heat treated for high corrosion resistance was found to be particularly poor in 600°F water. (auth)

2453 FRACTURE OF ZIRCONIUM ALLOYS IN IODINE VAPOUR. Garlick, A.; Wolfenden, P. D. (United Kingdom Atomic Energy Authority, Sellafield, Eng. J. Nucl. Mater.; 41: No. 3, 274-92(Dec 1971).

Zirconium alloy tubing in the cold-worked condition has proved susceptible to short-term brittle transgranular cracking when exposed to iodine vapor over the temperature range 250 to 510°C at tensile hoop stresses close to the 0.2% proof level. Thermal annealing reduced the cracking susceptibility of Zircaloy fabricated by cold-drawing but did not completely remove it after 850°C, 1 hr; in contrast a 650°C, 1-hr anneal was sufficient to prevent cracking in tube-reduced Zircaloy. Textural differences arising from the forming processes are considered to be responsible for this behavior. Since the failures resulted from metal–gas interactions, the dominant mechanism is suggested to be one of mechanical fracture rather than electrochemical attack, a conclusion supported by results of fractographic examination. (auth)

2454 CUTTING CORROSION PRODUCTS IN NUCLEAR PLANTS. Sawochka, S. G.; Pearl, W. L. Power; 115: No. 10, 83-4(Oct 1971).

Methods of reducing corrosion product concentrations in BWR cooling systems by using stainless steel tube heaters and by cladding materials exposed to cooling water in the reactor core with Zircaloy are reviewed. Steam pipes, turbine-extraction lines, feedwater-heater shells and drains, and pipes connecting heaters are fabricated using steel. Copper alloys are permitted in the condenser. Feedwater corrosion products are continuously removed. (J.R.D.)

2455 ELECTROCHEMICAL BEHAVIOR OF ZIRCONIUM IN FUSED CHLORIDE ELECTROLYTES. Kudyakov, V. Ya.; Smirnov, M. V.; Komarov, V. E.; Loginov, N. A.; Borodina, N. P. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 15, 10-17(1970). (In Russian).

Results obtained from measurements of diffusion coefficient and cathodic polarization and from a study of the equilibrium between Zr and its ions in different oxidation states in various fused salts are reported. The salt baths included alkali-metal chlorides, mixtures of alkali-metal chlorides, and mixtures of $MgCl_2$ and $SrCl_2$. Zr is thermodynamically reversible with respect to its 2 and 4-valent ions and the combined presence of these in an electrolyte has a significant effect on the mechanism of cathodic deposition. (Referativnyi Zh.)

2456 METHOD FOR THE PROTECTION OF METAL ARTICLES AT ELEVATED TEMPERATURES. Charveriat, Michel (to Ugine Kuhlmann). U. S. Patent 3,594,896. 27 Jul 1971. Filed 18 Nov 1968.

A method of protecting an article made of zirconium, titanium, hafnium, niobium, tantalum, vanadium or their alloys against high-temperature corrosion is described which consists of pickling the surface to be protected, galvanizing an alloy having an aluminum-silicon base containing the metal which is to be protected and an equivalent surface, and brazing the two surfaces together using a brazing metal selected from the group of copper, silver, beryllium, silicon or their alloys with one another. (Official Gazette)

2457 BEHAVIOR IN AN ELECTRIC FIELD AND THE NATURE OF SUPERIMPOSED OXIDE LAYERS PRODUCED ON URANIUM BY ANODIC OXIDATION UNDER CONTROLLED POTENTIAL AT pH 13. Jouve, G.; Aucouturier, M.; Beranger, G. (Paris Univ., Orsay, France). Compt. Rend., Ser. C; 273: No. 2, 110-13(12 Jul 1971). (In French).

Transmission diffraction experiments were performed on the nature of the two superimposed layers produced on U by anodic oxidation under controlled potential at pH 13. They confirmed that the superficial layer consists of UO_3, $2H_2O$, and an underlying layer of UO_2. The UO_3, $2H_2O$ layer increases with a linear kinetics; a second type of kinetics attributed to UO_2 growth appears simultaneously with cracking in the UO_3, $2H_2O$ layer. Conductivity experiments were made in order to determine the effect of the UO_3, $2H_2O$ layer on the oxidation mechanisms. (France)

2458 CORROSION RESISTANT MATERIALS FOR ACID ELECTROLYTE FUEL CELLS. PART II. Sayano, R. R.; Mendelson, R. A.; Seo, E. T.; Silverman, H. P. (TRW Inc., Redondo Beach, Calif.). pp 178-82 of Proceedings of the 24th Power Sources Symposium. Red Bank, N. J.; PSC Publications Committee (1970).

From twenty-fourth power sources symposium; Fort Monmouth, N. J. (19 May 1971).

Testing of materials for use in fuel cells in which H_3PO_4 is used as electrolyte is described. Alloys tested include those composed of Mo–Ti, Mo–Nb–Ti–V, Nb–V, Co–Ni, Ni–Ta, Ta–Ti, Co–Mo, Mo–Ni–Ti, Nb–Ni, and Ni–Ta–Ti. Nickel-base and Co-base superalloys were also tested. Alloys found most resistant to corrosion by H_3PO_4 were 20Mo–Ti, 70Ni–Ta,

and 23Mo–30Nb–35Ti–12U. Hastelloy B was found most resistant among the superalloys. (J.R.D.)

2459 MECHANISM OF OXIDATION OF Zr–1 PERCENT Nb ALLOY IN PRESSURIZED STEAM. El-Shanshoury, I. A.; Rudenko, V. A. (Atomic Energy Establishment, Cairo). Corros. Sci.; 11: No. 10. 779-85(Oct 1971).

A mass spectrometric analysis of ZrO_2 powder obtained as a corrosion product of Zr–1% Nb alloy in pressurized steam at 500°C and 400 atmospheres was carried out. It was found that the oxide film contained H_2O, H_2^+, and H^+. The amounts of H_2^+ at different test temperatures were found to be much higher than those of H_2O and H^+. Activation energies of 68.5 and 40.0 kcal/mole were required to release H_2^+ and H^+, respectively from ZrO_2 films. A model based on the presence of H_2^+ and H^+ in the structure of the oxide film is presented to explain the agressive nature of pressurized steam. (auth)

2460 CORROSION OF THERMOCOUPLE MATERIALS IN A PWR ENVIRONMENT. Tkach, J. D.; Meservey, R. H. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc.; 14: No. 2, 571-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2461 INTERACTION OF VOLATILE FISSION PRODUCTS WITH AUSTENITIC STAINLESS-STEEL CLADDING ALLOYS. Maiya, P. S. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 599-600(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2462 OBSERVATIONS ON THE SYSTEM Na–N_2–Ca TYPE 304 STAINLESS STEEL. Fischer, Albert K.; Cafasso, Fred A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 624(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2463 CORROSION IN POLYTHERMAL LIQUID METAL AND FUSED SALT LOOP SYSTEMS. Koger, J. W.; Evans III, R. B.; DeVan, J. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 627(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2464 ELECTROCHEMICAL FACTORS OF STRESS CORROSION CRACKING OF ZIRCONIUM IN CH_3OH + HCl SOLUTION. Elayaperumal, K.; De, P. K.; Balachandra, J. (Bhabha Atomic Research Centre, Bombay). Corros. Sci.; 11: No. 8, 579-89 (Aug 1971).

In order to throw some light on the mechanism of stress corrosion cracking (scc) of annealed zirconium in CH_3OH + 0.4% HCl solution electrochemical studies, such as the variation of potential with time, cracking behavior under controlled potentials, and effects of stress on cathodic and anodic polarization curves were carried out. Also the effects of applied stress on the corrosion rate and the effects of the above solution on the mechanical properties were studied. The results indicate that scc of annealed zirconium in CH_3OH + 0.4% HCl is one of stress-aided intergranular anodic dissolution process. (auth)

2465 GALVANIC CORROSION OF AUSTENITIC Fe–Cr–Ni ALLOYS IN NITRIC MEDIA. BEHAVIOR OF Fe–Cr–Ni AUSTENITIC ALLOYS IN THE TRANSPASSIVATION REGION. Brunet, S.; Coriou, H.; Grall, L.; (and others) (CEN, Fontenay-aux-Roses, France). Mem. Sci. Rev. Met.; 68: No. 7, 489-97(Jul 1971). (In French).

The effects of various factors on the corrosion in the transpassivation region were studied: HNO_3 concentration, temperature, steel/graphite ratio for the coupled surfaces, coupling with noble metals, and the crystalline state. Steel/graphite coupling, which can occur when fuel elements with a graphite core are dissolved, is emphasized. Two commercially available austenitic steels (18% Cr, 10% Ni and 25% Cr, 20% Ni), a 17% Cr, 14% Ni steel, and a single crystal sample with almost the same composition as the 17% Cr, 14% Ni steel were studied. Coupling involves strong corrosion (dissolution and intergranular corrosion). (France)

2466 CORROSION RESISTANCE OF METALS AND ALLOYS IN FLUOROSILICIC ACID. Bozin, N. A.; Uspenskaya, M. M.; Maksudov, G. A. Zashch. Metal.; 5: No. 6, 668-71(1969). (In Russian).

Chromium, Mo, and W showed the greatest corrosion resistance in 10% H_2SiF_6, while Ni, Nb, and even Ta had low resistance (0.5 to 1.0 mm/year). (Referativnyi Zh.)

2467 CORROSION RESISTANCE OF METALS IN IODINE AND IODINE-CONTAINING MEDIA. Ginzburg, V. I.; Kabakova, O. I. Zashch. Metal.; 5: No. 6, 627-32(1969). (In Russian).

A study was made of the relationship between the corrosion of a number of metals and the temperature of liquid and gaseous iodine. Temperature limits were established for the use of structural metals in such media. For alloy steels and Ni–Cr alloys at 170 to 230°C, susceptibility to pitting increased sharply in gaseous iodine, liquid iodine; Nb, Ta, Mo, and alloys of these were highly resistant under the same conditions and did not undergo pitting corrosion. Pb, Cu, Zn, and carbon steel corroded severely in gaseous iodine from 20 to 700°C. Up to 250°C, alloy steels and Ni–Cr alloys corroded relatively slowly (less than 0.5 $g/m^2 \cdot$ hour), but underwent pitting corrosion, while Ta, Nb, and their alloys were not susceptible and were highly resistant (below 0.01 $g/m^2 \cdot$ hour). Above 250°C, the corrosion rate of all the materials studied increased. Most metals corroded severely in HI synthesis conditions (a mixture of $H_2 + I_2 + HI$) at 370 to 400°C. Pt, alloy Kh7OM27F, Mo, and Mo alloys had the lowest corrosion rate, below 0.3 $g/m^2 \cdot$hour. Recommended materials for gaseous iodine up to 250°C are Ta, Nb, and their alloys; up to 300°C Kh17N13M2T and NP-2; up to 330°C Kh23N28M3D3T; up to 450°C KhN78T and N7OM27F; up to 700°C Mo and alloy TsM-2A: for gaseous $I_2 + HI + H_2$ up to 250°C KhN78T; up to 400°C Pt, Mo, alloy TsM-2A, and N7OM27F. (Referativnyi Zh.)

Preparation and Fabrication

Refer also to abstracts 2142, 2185, and 2192.

2468 METHOD OF ELECTRON-BEAM WELDING. Itoh, Fujio R. (to United States Atomic Energy Commission). U. S. Patent 3,602,685. 31 Aug 1971. Filed 28 Jun 1966.

A method of electron-beam welding is disclosed, particularly for welding alloys such as Zircaloy-2 or -4. Narrow, deep welds of minimal porosity are produced by defocusing the beam at its point of impingement on the joint. A short, narrow dike is provided on the surface of the joint within which pressure of the molten metal is built up. This pressure suppresses appreciable loss of alloying components from the weld metal. (Official Gazette)

2469 PREPARATION OF TANTALUM METAL. Wilhelm, Harley A.; Schmidt, Frederick A.; Bergman, Roger M. (to United States Atomic Energy Commission). U. S. Patent 3,597,192. 3 Aug 1971. Filed 5 Dec 1968.

An improved method is described for preparing high-purity tantalum metal by the alumino-thermic reduction of Ta_2O_5. By adding selected alloying agents (Fe, Si, and/or Mn) to the aluminum and tantalum oxide, a massive metal alloy readily separable from the slag is produced upon reduction of the mixture. The high-purity tantalum metal is then recovered by heating the alloy under reduced pressure to a temperature sufficient to boil off the alloying metals. (Official Gazette)

2470 RARE EARTH ADDITIONS TO URANIUM AND URANIUM ALLOYS. Jaynes, George E. (to United States Atomic Energy Commission). U. S. Patent 3,600,157. 17 Aug 1971. Filed 7 May 1969.

For neutron flux determination, yttrium or lanthanide rare earth metals are added to uranium and uranium alloys in the range of 0.1 to 0.3 wt. %. Nickel, cobalt, and rhodium in a weight ratio of 2:1 are used as carrier metals for the rare earths. (Official Gazette)

2471 IMPROVED BRAZING METHODS FOR TUNGSTEN CARBIDE TOOL BITS. Gilliland, R. G.; Adams, C. M. Jr. (Univ. of Wisconsin, Milwaukee). Weld. J. (N. Y.); 50: No. 7, 267-s-74-s(Jul 1971).

The fabrication of tungsten carbide-containing working tools has long relied on brazing as the joining method. A study was conducted directed toward a better understanding of the more fundamental aspects, both metallurgical and mechanical, of this composite joint. The studies were performed using dissimilar joints of tungsten carbide and 4340 steel. Four filler metals were used to make the joint. Vacuum atmospheres were consistently utilized with heat sources being either electron beam or resistance-furnace. Room temperature mechanical property testing was performed using specially designed specimen holding assembly. Other studies were concerned with substrate wetting, braze joint metallographic and microprobe analysis, and fracture surface analysis. The results indicated that excellent liquid metal wetting can be accomplished on both tungsten carbide and steel surfaces. This is especially true when using pure (OHFC) copper as the filler metal. Most consistent results are obtained when resistance heating is used. Metallographic and electron beam microbeam probe analysis of the composite revealed only minor reactions between the substrates and the liquid metal. Mechanical property tests revealed many interesting facts about the behavior of a brazed joint

during plastic deformation. Inhomogeneous strain was observed across the joint, with maximum deformation localized within the filler metal. Maximum shear strengths were found when using copper as a filler metal (30,000 psi), with maximum shear stress of the order of 1000%. Fractographic studies of the failed surfaces exhibited the characteristic features of ductile, simple shear. (auth)

2472 PURIFICATION OF METALS AND SEMICONDUCTORS BY CRYSTALLIZATION. Vigdorovich, V. N. Tel-Aviv, Israel; Freund Publishing House, Ltd. (1971). 301p.

Translation of Ochistka Metallov i Poluprovodnikov Kristallizatsiei.

The theoretical aspects and experimental techniques of purification processes are examined and discussed. Special attention is directed to the behavior of various impurities associated with crystallization and to the physicochemical mechanisms of crystallization. (J.R.D.)

2473 BRAZING OF REFRACTORY, SUPERALLOY, AND COMPOSITE MATERIALS FOR SPACE SHUTTLE APPLICATIONS. Beuyukian, C. S. (North American Rockwell Corp., Downey, Calif.). Weld. J. (N. Y.); 50: No. 7, 491-9(Jul 1971).

The shuttle orbiter heat shield will be fabricated from various materials, both metallic and nonmetallic. Nonmetallic areas are expected to reach temperatures as high as 3200°F, while the metallic portions will be subjected to temperatures approaching 2500°F. Work reported pertaining to the orbiter heat shield is confined to the metallic portion. Five different metals are being evaluated. The materials are TD–Ni–Cr, Cb–C129Y, Cb752, Haynes 188, and Inconel 625. Joining these materials into panels for heat shield applications is of major concern. Brazing is an established and reliable method of joining thin-membered assemblies and is characterized by certain advantages in fabricability. Use of the vacuum-furnace brazing process is being investigated as a primary or supplemental process to join materials for use on the shuttle orbiter heat shield. Brazed aluminum–boron metal-matrix-contoured composite structures are also being evaluated for shuttle orbiter applications. These high strength structures are viewed with considerable interest and may be used extensively. (auth)

2474 DEVELOPMENT OF BRAZING FILLER METALS FOR ZIRCALOY. Beal, R. E. (Illinois Inst. of Tech., Chicago); Saperstein, Z. P. Weld. J. (N. Y.); 50: No. 7, 275s-291s(Jul 1971).

The development of brazing filler metals for use in a water-cooled reactor environment has been undertaken. A dynamic chemical shim-resistant filler metal for brazing Zircaloy-2 and Zircaloy-4 material was required. Over 150 candidate filler metals were investigated for brazing capability and corrosion resistance. A number of brazing filler metals have been developed that are considered suitable for the application with moderate corrosion rates and good joint mechanical strength. These filler metals are Zr–50Ag, Zr–29Mn, and Zr–24Sn. Seven other filler metals from the original selection proved to have good corrosion resistance but inferior mechanical properties. (auth)

2475 MICROSEGREGATION IN AUTOGENOUS HASTELLOY X WELDS. Savage, W. F.; Krantz, B. M. (Rensselaer Polytechnic Inst., Troy, N. Y.). Weld. J. (N. Y.); 50: No. 7, 292-303s(Jul 1971).

Results of solute analyses at fusion subgrain and grain boundaries are presented which show that only sulfides and carbides are detrimental to hot-cracking resistance. (J.R.D.)

2476 MACHINING AND GRINDING OF COBALT-BASE ALLOYS. Olofson, C. T.; Gurklis, J.; Morral, F. R. Brussels; Centre d'Information du Cobalt ([1971]). 72p.

Heat-resisting alloys are generally difficult to machine due to such inherent characteristics as high-shear stresses, high work-hardening capacities, hard abrasive intermetallics in the microstructure, and high cutting temperatures. The overall result is short tool life and high machining costs. Selections of high-quality machine tools, appropriate cutting tools, and proper setup conditions help to minimize those deleterious effects on machining. This means the use of heavy duty, vibration-free machine tools, sharp tools having correct tool geometries, positive feeds, low cutting speeds, adequate depths-of-cut, and appropriate cutting fluids. These subjects are summarized for milling, turning, drilling, tapping, reaming, broaching, grinding, and sawing. Information on electrochemical machining, electrolytic grinding, and chemical milling is also provided. (auth)

2477 NEW METHOD OF ELECTROPOLISHING NIOBIUM. Diepers, H.; Schmidt, O.; Martens, H.; Sun, F. S. (Siemens AG, Erlangen, Ger.). Phys. Lett.; 37A: No. 2, 139-40(8 Nov 1971).

A new method of electropolishing niobium was used to obtain very smooth surfaces. In the method, the voltage is switched on and off, creating current oscillations. In electropolished TE_{011}-cavities with an anodic oxide film, a Q-value of 3×10^{10} and a critical magnetic field of 80 mT were obtained in the X-band without any heat treatment. (auth)

2478 DISPERSION-STRENGTHENED FERRITIC STEELS FOR FUEL ELEMENTS IN FAST REACTORS. Huet, J.-J. Metallurgie (Mons, Belg.); 10: No. 4, 126-30(1970). (In French).

The preparation of dispersion strengthened Fe–13% Cr–2% Mo alloys containing TiO_2 4 to 8 vol. % is described. The mechanical properties of these materials were studied at 700°C. The improvement caused by the addition of TiO_2 is attributed to the formation of complex oxides (e.g. $Fe_2O_3 \cdot TiO_2$ and $(CrFe)_2O_3 \cdot 2TiO_2$). The behavior under irradiation of these alloys, which also contain additions of Ti or W, is superior to that of Ni-bearing austenitic steels. (Metals Abstr.)

2479 CHARACTERIZATION OF HEAVY SECTION STFEL WELDMENTS. Canonico, D. A. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 585(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2480 PLASMA-ARC WELDING OF AN ISOTOPE CAPSULE. Goodwin, G. M.; Early, B. F. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 591-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2481 FIXTURE DEVELOPMENT FOR ROBOTIZED PRODUCTION OPERATIONS. Bert, J. D.; Ramer, P. C.; Zybura, J. G. (Dow Chemical Co., Golden, Colo.). Trans. Amer. Nucl. Soc.; 14: No. 2, 877(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2482 PROCEDURE FOR PRODUCING BULK METAL FROM METALLIC OXIDES. Gallay, J. J.; Jurien de la Graviere, Marcel; Jurien de la Graviere, Jean; Hilary, Louis (to Commissariat a l'Energie Atomique). French Patent 2,052,082. 29 Mar 1971. Filed 11 Jul 1969. (In French).

A procedure for manufacturing metallic ingots by direct reduction from metallic oxides without involving an intermediate compound is described. The process is particularly suitable for actinides (except actinium), lanthanides, and certain expensive metals. It is also very suitable for enriched uranium, for which the quantity of metal treated in each operation is relatively small. A mixture consisting of the oxide to be reduced and an alkaline or an alkaline earth reducing metal and its fluoride is heated until the reaction is initiated. The fluoride when in the molten state provides a solvent for both the reducing metal and the oxide formed in the reaction. (France)

2483 STAINLESS STEEL WITH A HIGH BORON CONTENT. (to Ugine Kuhlmann). British Patent 1,244,876. 2 Sep 1971. Priority date 5 Dec 1967, France.

The development of stainless steels with a high boron content in which disadvantages of steels containing 18% Cr and 10% Ni and 0.5 to 4 or even 5% B by weight are minimized or eliminated is described. The steels described contain 20 to 30% Cr, 5% and preferably 1% Ni, and 0.5 to 6% B. It was possible to forge components made of this steel. (P.C.H.)

2484 PREPARATION OF LIQUID METAL WORKING MEDIA FOR RADIATION LOOPS. Kiknadze, G. I.; Zakharov, D. M.; Lyudvigov, R. B.; Fel'dman, L. I. At. Energ. (USSR); 31: No. 2, 146(Aug 1971). (In Russian).

In working with liquid metal γ-carriers, e.g., In–Ga or In–Ga–Sn alloys, it is advisable to use materials of construction which are not attacked by the alloy. Degassing to eliminate oxygen and other gases, and prolonged heating at an elevated temperature (500°C) with helium sparging are both recommended. Cooling to room temperature slowly (2 to 3°/min), careful filtration, and periodic analysis of the components of the alloy are also discussed. (K.S.W.)

2485 IMPROVEMENTS IN OR RELATING TO ZIRCONIUM ALLOYS. (to Sandvikens Jernverks Aktiebolag). British Patent 1,252,238. 3 Nov 1971. Priority date 21 Feb 1969, Sweden.

A method is described for manufacturing a Zr alloy which, besides Zr and an insignificant amount of impurity, contains 0.2 to 2.5% by weight of Sn and 0.1 to 4% by weight of one or more of the elements Fe, Cr, Ni, and Nb in order to give the alloys a higher ductility and improved surface properties. (P.C.H.)

Properties Evaluations

Refer also to abstracts 2133, 2137, 2186, 3134, 3142, 3144, 3145, and 3148.

2486 (CEA-R-4238) STUDY OF THE DIFFUSION OF PLUTONIUM IN A Mg-Zr ALLOY: CONSEQUENCES AND METHODS OF INHIBITION. Faussat, Armand; Houdaille, Brigitte; Millet, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1971. 75p. (In French). Dep. NTIS (U. S. Sales Only).

The diffusion of plutonium through a magnesium zirconium alloy leads to a parasitic increase of the signal used in failed element detection and location. The study of this phenomenon and its effect on FEDAL has permitted the initial fuel element load in the EDF-1 reactor to be used without any modifications. Two solutions were developed to overcome this problem: a colloidal graphite layer was interposed between the uranium and the can and was used for the assembly of tubular elements; the plutonium was sealed by an aluminum deposit formed by flame metallization; furthermore this latter method allowed a metallurgic bonding between the uranium and the cladding for the annular element of BUGEY 1 to be made. (France)

2487 (CU-3712-20) DILATOMETRIC AND X-RAY THERMAL EXPANSION IN NON-CUBIC CRYSTALS. II. EXPERIMENTS ON CADMIUM. Feder, R. (IBM Watson Research Center, Yorktown Heights, N. Y.); Nowick, A. S. (Columbia Univ., New York. Henry Krumb School of Mines). [1971]. 44p. Dep. NTIS.

Precision measurements of macroscopic thermal expansion $\delta l/l_0$ and microscopic (x-ray) thermal expansion $\delta d/d_0$ have been carried out for cadmium single crystals in both the a and c directions, between room temperature and the melting point. In accordance with a previous prediction it was found that the difference $\Delta = (\delta L/L_0) - (\delta d/d_0)$ in a given direction is sample dependent. Accordingly, information on the equilibrium defect concentration was obtained from samples cut from the same large crystal. The mole fraction of vacancies in equilibrium, given by $2\Delta_a + \Delta_c$, has the value 5.6×10^{-4} at the melting point. The results as a function of temperature are consistent with an interpretation in terms of monovacancies only, with enthalpy and entropy of formation, respectively of 0.40 ± 0.02 eV and 0.3 ± 0.4°K. With the aid of self diffusion data, appropriate vacancy migration parameters are also obtained. In addition, the ratio Δ_c/Δ_a is found to be independent of temperature, and is interpreted in accordance with theory. In particular, it is found that non-basal dislocations play a large role as sources and sinks for vacancies. (auth)

2488 (N-71-30632) DEVELOPMENT OF NIOBIUM ALLOY WC3015. Tavassoli, A. A. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). Jul 1971. 26p. (NASA-TN-D-6390). NTIS.

The effects of changes in basic composition and additions of alloying elements on mechanical properties of Nb alloy WC3015 are reported. A 500-ppM addition of yttrium to the basic composition plus an anneal for 1 hr at 1093°C provided a superior combination of properties with a ductile-to-brittle transition temperature below -129°C. Nevertheless, the oxidation resistance of WC3015 was found to be inadequate for a typical reentry environment. The oxidation rate of WC3015 was found to be parabolic at 1316°C (2400°F), resulting in an oxidation rate higher than Nb 752, for times less than 40 min. It was concluded that since oxidation resistance obtained at the expense of ductility and elevated temperature strength is not justified for thermal protection system application, more emphasis should be placed on improving ductility, elevated temperature strength, and creep. Substitution of over 10% of the hafnium by tantalum and elimination of titanium is suggested for improving the above properties. (auth) (STAR)

2489 ROOM AND ELEVATED TEMPERATURE PROPERTIES OF BALL-MILLED ALUMINIUM ALUMINIUM OXIDE ALLOYS. Kothari, N. C. (Univ. of North Queensland, Townsville, Australia). J. Nucl. Mater.; 41: No. 3, 303 12(Dec 1971).

Mechanical properties of ball-milled aluminum powder were determined at room and elevated temperatures. A reduction in particle size of matrix material (aluminum powder) with a limited increase in the oxide content was obtained by ball-milling in a controlled oxidizing atmosphere. The strength properties at room and elevated temperatures were better than those obtained in SAP or mechanically mixed aluminum-powder-plus-oxide alloys. The increase in the strength properties of the ball-milled alloys is due to uniform distribution of oxide phase in the matrix and the reduction obtained in the particle size of the aluminum powder during milling. (auth)

2490 HARDNESS OF W, Mo, Ta, AND W-Mo ALLOYS AT HIGH TEMPERATURES. Kinoshita, Takuji; Sobajima, Masaru; Yamane, Yoshio (Nippon Kogaku K.K., Tokyo). Zairyo; 20: No. 210. 425-30(Mar 1971). (In Japanese).

A new hardness tester has been designed for temperatures as high as 1,600°C, which was used in the present experiment for measurements on tungsten, molybdenum, tantalum, and tungsten-molybdenum alloys. The following results were found: (1) tungsten and molybdenum, when work hardened, will gain in temperature strength to a point below their recrystallization temperature; (2) in tungsten, molybdenum, and tantalum, the temperature for the ductile-to-brittle transition is correlated with the bend point which represents the rate of hardness integrity of these metals respectively against heat, on the curve of the testing temperature; (3) molybdenum indicated a bend point at Th + 0.4, where its remarkable softening began, while tungsten showed no clear bend point below Th = 0.5; (4) tungsten-molybdenum alloys, though they ranged between tungsten and molybdenum in maintaining their integral hardness at room temperature, showed even higher rate of hardness integrity against heat than tungsten in a certain temperature range; (5) the rate of hardness integrity of tungsten, molybdenum, and tantalum against heat was found to be within the range of scattered data obtained by other investigators; and (6) molybdenum, cast or annealed, appears to have rate of hardness integrity against heat in proportion to its tensile strength at high temperature. (auth) (Japan)

2491 PLASTIC DEFORMATION AND FRACTURE IN TENSION OF WC-Co ALLOYS. Fujiwara, Yoshio (Mitsubishi Metal Mining Co. Ltd., Tokyo); Miyake, Kazuo; Doi, Hidekazu; Oosawa, Yuzo. Funtai Oyobi Funmatsuyakin; 17: No. 8, 347-54(May 1971). (In Japanese).

Plastic deformation and fracture of WC-Co alloys in tension have been studied as a function of composition (6 to 24 wt % Co), WC particle size (1.3 to 2.4 μ), and carbon concentration. Although tensile fracture strain of the alloys is in general much less than compressive fracture strain, the tensile stress-strain curves can completely be superposed on the compressive stress-strain curves. This result suggests that the deformation mechanisms are the same in tension and in compression, i.e., of dispersion strengthening type. The tensile strength of the alloys with optimum carbon concentration and fixed WC particle size plotted against the mean free path shows a peak at ~0.4 μ. With a decrease in WC particle size, the strength curve shifts towards the higher strength side, accompanied by an increase in ductility. Fractographic analysis by scanning electron microscopy reveals that tensile fracture is predominantly intergranular. Internal friction of the alloys increases with plastic deformation and also after the fracture even when the fracture occurs essentially in the elastic range. This suggests that plastic straining due to stress relaxation has occurred in the Co phase in some stage of tensile deformation. The nature of tensile fracture of the alloys was discussed in some detail on the basis of the above observations. (auth) (Japan)

2492 COMPARISON OF DIFFUSION PENETRATION PLOTS OBTAINED FROM ALPHA ENERGY DEGRADATION AND ELECTROCHEMICAL SECTIONING. Kroeger, D. M. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater.; 41: No. 3, 345-7 (Dec 1971).

A technique is reported for calculating penetration plots directly from the alpha spectrum. The technique is compared with the electrochemical sectioning technique (anodizing-stripping) for ^{233}U after diffusion into Ta single crystals. The two penetration plots coincide exactly if a dE/dX value of 448 keV/μ is used; both plots have two linear regions. (D.L.C.)

2493 EXTENDED PLASTICITY IN FINE-GRAINED ALPHA PLUTONIUM. Merz, M. D. (Battelle-Northwest, Richland, Wash.). J. Nucl. Mater.; 41: No. 3, 348 50(Dec 1971).

Results are given of tensile tests of extruded alpha-Pu at 25 and 108°C. The 108°C test gave very high elongation (200 to 218%) for the extruded metal, as did the metal quenched from the epsilon phase. At 25°C, the elongation of the extruded metal was 8%, and the ultimate tensile strength was 76,000 psi. The true stress-strain curve indicated work hardening. It is concluded that the prevention of void formation and coalescence is the cause of the higher elongation of fine-grained metal. (D.L.C.)

2494 SOLUBILITY OF NITROGEN AND THE EQUILIBRIUM OF Nb-NITRIDE FORMING REACTION IN LIQUID Fe-Nb ALLOYS. Morita, Zen-ichiro; Hachisuka, Kunio; Iwanaga, Yuji; Adachi, Akira (Osaka Univ.). J. Jap. Inst. Metals; 35: No. 9, 831-9(Sep 1971). (In Japanese).

Solubility of nitrogen and equilibrium of Nb-nitride forming reaction in liquid Fe-Nb alloys under the presence and the absence of Nb nitride was measured by the sampling method at

1600, 1650, and 1700°C in the concentration range of 0 to 30% Nb, and the behavior of niobium and nitrogen was thermodynamically discussed through these experimental results. The solubility of nitrogen markedly increased with increasing niobium concentration in liquid alloy in the absence of Nb nitride, and it decreased with increasing temperature especially at the higher concentrations of niobium. On the other hand, it decreased with increasing niobium concentration in the presence of Nb nitride. The interaction coefficient of niobium, $f_N^{(Nb)}$ can be expressed as a function of niobium concentration at each temperature as follows: $\log f_N^{(Nb)} = -0.086$ [% Nb] + 0.0019 [% Nb]^2 at 1600°C; $\log f_N^{(Nb)} = -0.079$ [% Nb] + 0.0018 [% Nb]^2 at 1650°C; and $\log f_N^{(Nb)} = -0.067$ [% Nb] + 0.0014 [% Nb]^2 at 1700°C. The Nb nitride appearing in the liquid Fe–Nb–N system was confirmed to be hexagonal and cubic NbN by Debye–Scherrer x-ray diffraction analysis. The standard free energy of decomposition of NbN was determined to be $\Delta G^0 = 50{,}800 - 24.6\ T$. The self-interaction parameter of niobium, $e_{Nb}^{(Nb)}$ was also estimated as zero. The empirical equations for estimating the solubility limit of niobium when the nitride begins to form in liquid Fe–Nb alloys under a given nitrogen pressure were obtained as follows: 0.0013 [% Nb]^2 −0.081 [% Nb] + 0.735 − $\log \sqrt{P_{N_2}} = 0$ at 1600°C, 0.0011 [% Nb]^2 −0.069 [% Nb] + 0.694 − $\log \sqrt{P_{N_2}} = 0$ at 1650°C, 0.0007 [% Nb]^2 −0.050 [% Nb] + 0.635 − $\log \sqrt{P_{N_2}} = 0$ at 1700°C. (auth)

2495 SPECIFICATION FOR CARBON AND LOW ALLOY STEEL CONTAINMENT STRUCTURES FOR STATIONARY NUCLEAR POWER REACTORS. BS 4208 1967. London; British Standards Institution (1967). 88p. Available from American National Standards Institute, New York.

The standard is concerned with design, construction, inspection, and testing of steel reactor containment structures for use at temperatures not exceeding 300°C. (J.R.D.)

2496 KINETICS OF DIFFUSION OF HYDROGEN IN NIOBIUM. Ogurtani, T. Oe. (Middle East Technical Univ., Ankara). Met. Trans.; 2: No. 11, 3035-8(Nov 1971).

The kinetics of hydrogen diffusion in niobium were studied in the temperature ranges of 200 to 300°C and 600 to 700°C by gas-metal absorption experiments. The hardness profile was correlated with the concentration of hydrogen on specimens of various grain sizes. It was found that the diffusion kinetics of both temperature ranges could be represented by a single Arrhenius-type rate equation. The activation energy and the preexponential factor were found to be 10,000 ± 320 cal per mole, and $1.8 \pm 1.0 \times 10^{-2}$ cm^2 per sec, respectively. No observable effect of grain size was found on the diffusivity. (auth)

2497 THERMAL MICROSTRESSES IN BERYLLIUM AND OTHER HCP MATERIALS. Armstrong, R. W. (Univ. of Maryland, College Park); Borch, N. R. Met. Trans.; 2: No. 11, 3073-7(Nov 1971).

The thermal stresses that may develop due to crystal anisotropy within the microstructure of beryllium and certain other hcp materials are described. The magnitude of the unrelaxed thermal stress in polycrystalline beryllium is estimated numerically. The calculated values for the local thermal stresses that might occur in polycrystalline beryllium are comparable to the bulk stresses that are measured for yielding and fracture. The possible influence of these stresses on the initiation of cleavage cracks in rolled beryllium sheet and in extruded beryllium plate is described. (auth)

2498 EFFECT OF FREQUENCY OF THE CYCLIC STRAIN AND LOW CYCLE FATIGUE BEHAVIOR OF CAST UDIMET 500 AT ELEVATED TEMPERATURE. Coffin, L. F. Jr. (General Electric Co., Schenectady, N. Y.). Met. Trans.; 2: No. 11, 3105-13(Nov 1971).

An experimental investigation was undertaken on cast Udimet 500 to study principally the effect of frequency on low-cycle fatigue at temperatures from 730 to 900°C, but mostly at 815°C. Total strain range and stress range vs fatigue life relationships were determined which included the frequency following the form of recent work. The stress range was found to obey a power law relationship involving the fatigue life and frequency, such that at a specific stress range, a ten-fold decrease in frequency corresponded to a 3.7-fold decrease in life. While stress results were well-ordered with frequency, the scatter in the cyclic strain data was severe. A random crystallographic orientation of the few grains in the cross section led to an anisotropy in the material which produced as much as a three-fold variation in diametral strain around the circumference. Results were compared to those for directionally solidified Mar-M200. In load-controlled applications cast U-500 gave better life, while in strain-controlled situations, the directionally solidified material excelled. For $N_f > 1000$ cycles, the difference in life was related to elastic modulus. Evidence for cyclic strain aging is given, the peak effect occurring at 790°C. This temperature corresponds to that where the well-documented tensile ductility minimum occurs. (auth)

2499 FRACTOGRAPHIC OBSERVATIONS OF Ti–6Al–4V ALLOY FATIGUED IN VACUUM. Ritter, D. L.; Wei, R. P. (Lehigh Univ., Bethlehem, Pa.). Met. Trans.; 2: No. 11, 3229-30(Nov 1971).

Replicas shadowed with Cr were studied using an electron microscope. Ductile-appearing fatigue striations were observed whose spacings conformed to the measured crack growth rates. Tilting of the replica with respect to the electron beam was shown to increase contrast, showing striations in previously featureless regions. The results suggest that the mechanism for fatigue-crack growth in the Ti–6Al–4V alloy is similar for a wide range of environments e.g., vacuum, water, dry and wet gases. (D.L.C.)

2500 TIME-DEPENDENT HARDENING OF EXTRUDED α-PLUTONIUM. Merz, M. D. (Battelle Memorial Inst., Richland, Wash.). Met. Trans.; 2: No. 11, 3236-7(Nov 1971).

The hardness at 23°C of Pu extruded at 108°C was 204 Dph 4 hr after extrusion, increasing to 230 Dph after 400 hr at 23°C. The hardness 24 hr after extrusion was 185 Dph, increasing to 211 Dph after 400 hr. The hardness decreased with decreasing grain size. There was no evidence of grain growth, and self-radiation damage was ruled out because the hardening was retarded by holding at 77°K, indicating a thermally-activated process. (D.L.C.)

2501 THERMODYNAMIC MODELING OF BINARY AND TERNARY METALLIC SOLUTIONS. Sharkey, R. L.; Pool, M. J.; Hoch, M. (Univ. of Cincinnati). Met. Trans.; 2: No. 11, 3039-49(Nov 1971).

A model is proposed for describing heat of mixing behavior in binary and ternary metallic solutions. The binary model, which has the form, $\Delta H^M = \alpha_1 X_A^2 X_B + \alpha_2 X_A X_B^2 - \alpha_3 X_A^2 X_B^2$, where X_A and X_B are mole fractions of components A and B and α_1, α_2, and α_3 are constants, is applied to the heat of mixing values for 84 solid and liquid systems and the results are compared with the sub-regular model. The ternary model, which is composed of the sum of the binary equations and a ternary interaction term of the form $\alpha_{ABC} X_A X_B X_C$, was applied to the Bi–Cd–Pb, Cd–Pb–Sn, and Cd–Pb–Sb systems. There was excellent agreement both as to the shapes of the isoenthalpy of mixing curves and as to the heat of mixing values in the ternary systems when the model was used to predict the experimental values. (auth)

2502 STUDY OF POLYNARY URANIUM Mo–Zr–Nb–V ALLOYS. Tardif, H. P. (Canadian Defence Research Staff, London). Trans. Can. Inst. Mining Met.; 71: 326-41(1968).

In a continuing investigation into the development of uranium alloys for armament applications, some complex base alloy compositions were modified by varying the amount of alloying elements and by removing one or two of the alloying elements in turn from the base alloys. These uranium-base alloys were specially formulated in a search for heat-treatable, high-strength, ductile, high-density alloys. All alloys studied were ternary, quaternary or more complex alloys of uranium with molybdenum, zirconium, niobium and vanadium. Each cast alloy was studied under three different heat treatments, and its mechanical and corrosion properties were determined. It was found that although most of the alloys studied had the hardness and strength required, they were extremely brittle and notch-sensitive under tensile stresses. (auth) (Canada)

2503 CONTAINER MATERIALS FOR MOLTEN $SmCo_5$. Miller, J. F.; Austin, A. E. (Battelle Memorial Inst., Columbus, Ohio). J. Less-Common Metals; 25: No. 3, 317-21(Nov 1971).

The reactions of molten samarium–cobalt with crucible materials have been investigated. Pyrolytic boron nitride was found to be the most satisfactory container material, giving the least reaction with, and contamination of, the melt. The samarium in the molten alloy was found to reduce all the refractory oxides and to dissolve borides and transition metal nitrides. (auth)

2504 THERMOELECTRIC POWER OF THE LIQUID ALLOYS IN THE TIN–INDIUM SYSTEM. Petrescu, N. (Center of Physical Chemistry, Bucharest). Rev. Roum. Chim.; 16: No. 7, 1059-68 (Jul 1971).

The thermoelectric power of the Sn–In liquid alloys was studied as a function of temperature and composition. At temperatures below 350°C, peculiarities in the compositional variations of the thermoelectric power were manifest in the 90 At. % Sn alloy corresponding to the solid-state γ phase. A correlation between the metastable phases produced by splat cooling and the short-range order phenomena in liquid alloys in the prefreezing range is proposed, which can be revealed by the study of the properties of the liquid. (auth)

2505 ELASTIC MODULI OF THULIUM AND YTTERBIUM FROM 4.2 TO 300°K. Rosen, M. (Nuclear Research Centre-Negev, Beer-Sheva, Israel). J. Phys. Chem. Solids; 32: No. 10, 2351-6(Oct 1971).

The longitudinal and transverse acoustic velocities of high-purity polycrystalline thulium and ytterbium were measured by a pulse technique at a frequency of 10 MHz between 4.2 and 300°K. The variation with temperature of the Young moduli E, shear moduli G, adiabatic compressibilities K_s, and Debye temperature θ_D were determined. The anomalies in the elastic properties observed in thulium were correlated with the magnetic changes known to occur in this metal at low temperatures. The shape of the compressibility curve suggests that the transition from the antiferromagnetic to the ferromagnetic state in thulium is a gradual process, extending over a temperature interval. No anomalies were observed in the elastic properties of the nonmagnetic ytterbium. The limiting values of the Debye temperatures (at 0°K) of thulium and ytterbium are 200 and 117.5°K, respectively. (auth)

2506 EFFECT OF LOADING FRICTION ON THE DUCTILITY OF IRRADIATED 304L STAINLESS-STEEL CLADDING. Franklin, D. G. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: No. 2, 559-60(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2507 FAILURE MECHANISMS FOR INTERNALLY PRESSURIZED THIN-WALL TUBES AND THEIR RELATIONSHIP TO FUEL ELEMENT FAILURE CRITERIA. Yaggee, F. L.; Li, Che-Yu (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 588-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2508 STRAIN RATE DEPENDENCE OF TYPE 316 STAINLESS-STEEL MECHANICAL PROPERTIES. Steichen, J. M. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 589(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2509 EFFECT OF A LIQUID-SODIUM ENVIRONMENT ON THE MECHANICAL PROPERTIES OF TYPE 316 STAINLESS STEEL. Flagella, P. N. (Westinghouse Electric Corp., Madison, Pa.); Hundal, R.; Ammon, R. Trans. Amer. Nucl. Soc.; 14: No. 2, 589-90(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2510 NEW PLATINUM-RHODIUM-TUNGSTEN CLADDING ALLOYS FOR SPACE ISOTOPIC HEAT SOURCES. Liu, C. T.; Inouye, H.; Donnelly, R. G. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 590-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2511 NATURE OF Cs AND I DEPOSITS IN SODIUM SYSTEMS. Colburn, R. P. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 626-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2512 THERMAL EXPANSIONS AND STRESSES IN SWOLLEN METAL FUEL ELEMENTS. Chang, L. K.; Lo, R. K.; Sehgal, B. R. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 628-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2513 USE OF A FUEL PERFORMANCE MODEL TO ANALYZE MATERIALS DATA. Homan, F. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 629(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2514 ANALYSES OF LOCA TRANSIENTS IN TERMS OF CLADDING EMBRITTLEMENT. Hobson, D. O. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 700-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2515 COMPUTER CODE FOR PREDICTING THE BEHAVIOR OF OXIDE FUELS IN ACCIDENTS. Watanabe, A.; Judd, A. M. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 733-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2516 DC ETCH OF METAL SURFACES: SURFACE TOPOGRAPHY AND BULK SUBSTRUCTURE OF TANTALUM. Touw, Theodore Richard. Syracuse, N. Y.; Syracuse Univ. (1971). 138p. University Microfilms Order No. 71-23,477.

Thesis.

Some metals develop a rippled surface when heated in vacuum with direct current (dc) or when in a temperature gradient. This phenomenon is known as "dc etch." Among the hypotheses that have been advanced to account for dc etch, some require a stable substructure in the bulk of the metal (e.g., dislocations or subgrain boundaries) to determine the positions and spacing of the dc etch surface structure. In the present work, ribbons of tantalum were heated with dc in vacuum to produce the surface structure at an early stage. The ribbons were then thinned locally by electropolishing from one side to produce specimens suitable for transmission electron microscopy. The dislocations and subgrain boundary fragments seen in transmission electron micrographs were not correlated in position or orientation with the dc etch surface structure. It is concluded that a stable bulk substructure is not a necessary condition for the dc etch surface structure to occur. (Diss. Abstr. Int., B)

2517 DEFORMATION PEAKS IN α-ZIRCONIUM. Doherty, J. E.; Gibbons, D. F. (Case Western Reserve Univ., Cleveland). J. Appl. Phys.; 42: No. 11, 4502-3(Oct 1971).

A set of values are reported for the Arrhenius parameters of the internal friction peak observed in the hcp α phase of deformed zirconium. These parameters ($\Delta H = 0.39$ eV and $\tau_0 = 2 \times 10^{-12}$ sec) are more consistent with the Wert–Marx empirical rule than those of Hasiguti et al.; the new data are also more comparable with the parameters for titanium ($\Delta H = 0.35$ eV and $\tau_0 = 2 \times 10^{-12}$ sec). (auth)

2518 ELECTROEROSIVE STABILITY OF CERTAIN HIGH-MELTING COMPOUNDS AND METALS. Mukha, I. M.; Globa, L. V. Appl. Elec. Phenomena (Engl. Transl.); 175-8(May-Jun 1969).

Translated from Elektron. Obrab. Mater.; 14-18(May-Jun 1969).

It is pointed out that the ideal electrode material for the electroerosive machining of metals should have high electroerosive stability, good electrical and thermal conductivity, comparatively low hardness, and adequate bending strength. The electroerosive stability of titanium, tungsten, tantalum, niobium, and their carbides was investigated. It was found that the carbides were subject to slightly more wear than the corresponding pure metals. An explanation of the results on the basis of electronic theory is attempted. Results of microstructural, spectral, and x-ray diffraction analysis and of microhardness measurements on the working surface of zinc and cadmium machining electrodes showed that a film consisting of chemical compounds of the base metal with iron is formed on the electrode surface during machining of steel in kerosene. (IAA)

2519 NEW METHOD OF EVALUATING MATERIALS SUSCEPTIBLE TO BRITTLE FRACTURE. Dusek, F. (Inst. of Physical Metallurgy, Brno); Sykora, M.; Mazanec, K. Kovove Mater.; 9: No. 1, 38-46(1971). (In Czech).

A new method is proposed for evaluating the susceptibility of steels to brittle fracture, using the absorption of stress waves. The conditions of brittle fracture in the sample tested were simulated by a stress wave of an amplitude of 160 kp/mm^2 and a length of 20 μsec produced by an explosive charge. Using the equations for the propagation of elastic stress waves, the dynamic yield strength and the absorption capacity were computed from the recorded time course of the stress wave. The measurements were performed on irradiated and nonirradiated samples of the Czechoslovak A-2 low-alloy steel. Exposure to a dose of 1.35×10^{19} n/cm^2 resulted in an increase of yield strength by 30 to 40% in the whole range of the investigated deformation rate (10^{-6} to 10^{-4} sec^{-1}). The amount of absorbed energy of the stress wave was reduced by 30%. The crack arrest temperature increased by 25%. (INIS)

2520 VANADIUM-BASE ALLOY HAVING A HIGH CREEP-RUPTURE STRENGTH AND AN IMPROVED RESISTANCE TO CORROSION. Wincierz, Peter; Ruhle, Manfred; Kuchler, Heinz; Borgstedt, Hans-Ulrich; Bohm, Horst Otto (to Metallgesellschaft Aktiengesellschaft). British Patent 1,241,133. 28 Jul 1971. Priority date 25 May 1968, Germany.

Description is given of a V-base alloy that was developed to have good creep-rupture strength in prolonged tests and a high resistance to corrosion and that is particularly suitable in nuclear reactors as a structural material or for cladding tubes and has a creep-rupture strength that is suitable for such use during a time of more than 10,000 hr. The alloy contains at least one of the alloying elements Ti, Zr, or Hf in a total quantity of not less than 1%, the content of Ti being not more than 5% by weight, the

content of Zr being not more than 1.2% by weight, and the content of Hf being not more than 1.2% by weight, a total of 5 to 20% by weight of Cr and/or Mo, and, as optional ingredients, 0.1 to 2% by weight of Si and/or 0.5 to 4% by weight of Ge, balance V, traces of usual metallic impurities that are due to the process of producing the V and, based on the V content, 400 to 3000 ppM O, 100 to 1500 ppM N, and 100 to 1500 ppM C, the total of O, N, and C being not in excess of 4000 ppM. (P.C.H.)

2521 PROPERTIES AND HEAT TREATMENT OF Ti–V AND Ti–V–Al ALLOYS. Moiseev, V. N. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 3-4, 203-6(Mar-Apr 1971). Translated from Metalloved. Term. Obrab. Metal.; 13: No. 3, 24-8(Mar 1971).

Studies were made on the properties and structure of Ti–V and Ti–V–Al alloys after quenching from phase transformation temperatures (750 to 950°C) and also after the optimal strengthening heat treatment—quenching from 800 to 900°C and aging at 450 to 550°C for 4 to 16 hr. With increasing V concentrations up to 15% in the Ti–V alloys the ultimate and yield strength increased, while the elongation and bending angle decreased. With further increase in the V content to 20%, the strength decreased and the plasticity increased, particularly the elongation. In Ti–V–Al alloys the strength was highest at the lowest V concentration. The strength increased and the plasticity decreased with increasing V content up to 9%. With an increase in the quenching temperature in the $\alpha + \beta$ region the ultimate strength increased and the elongation decreased for both alloys. Examination of the microstructure of both alloys in an optical microscope after annealing (at 700 and 800°) showed that it consisted of a finely dispersed $\alpha + \beta$ mixture in all cases. There was little difference in the microstructure from one alloy to another. (P.C.H.)

2522 MECHANICAL PROPERTIES OF Ti–Al–Cr AND Ti–Al–Cr–Mo ALLOYS. Khorev, A. I.; Glazunov, S. G.; Mukhina, L. G. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 3-4, 207-11(Mar-Apr 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 3, 28-34(Mar 1971).

The results of studies on Ti–Al–Cr and Ti–Al–Cr–Mo alloys (with concentrations of β stabilizing elements near the critical) showed that they have a high plasticity in the annealed condition, the strength reaching 120 kg/mm^2. Quenching and aging to increase the strength with retention of satisfactory plasticity can be used for Ti–Al–Cr alloys with not over 3.6% Cr and for Ti–Al–Cr–Mo alloys with up to 9% Cr + 15% Mo. The mechanical properties were determined for alloys overheated after annealing and after quenching and aging. At the same strength after quenching and aging of alloys with a small amount of stabilizing elements, and after annealing of alloys with a large amount of stabilizing elements, the plasticity was higher in the latter case. (auth)

2523 EFFECT OF β STABILIZERS ON THE MECHANICAL PROPERTIES OF TITANIUM ALLOYS WITH AN α STRUCTURE. Moroz, L. S.; Razuvaeva, I. N. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 3-4, 212-16(Mar-Apr 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 3, 34-9(Mar 1971).

The addition of β stabilizers to α titanium alloys with an original fine-grained structure increased the strength and the overall ductility, since the structure was refined and β phase was precipitated, with a bcc lattice, which has a larger number of possible slip planes than the α phase, with a fcc lattice. An increase in the amount of β stabilizer in alloys with a coarse-grained lamellar structure, which was formed during slow cooling from the β region, reduced the overall ductility in direct proportion to the concentration of β stabilizer. This was due to an increase in the degree of irregularity of plastic deformation in the alloy with a coarse-grained structure with increasing amounts of β stabilizer in the alloy. At concentrations of β stabilizer near the critical, an increase in the aluminum content to 6 to 8% sharply reduced the ductility regardless of the structural characteristics. This was evidently due to the supersaturation of α phase with aluminum and the occurrence of α_2 phase in separate sections. (auth)

2524 MECHANICAL PROPERTIES OF WELDED JOINTS OF TITANIUM ALLOYS WITH AN ELEVATED OXYGEN CONTENT. Gurevich, S. M.; Kornilov, I. I.; Blashchuk, V. E.; Vavilova, V. V.; Maksimov, Yu. A. (Inst. of Metallurgy, Moscow). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 3-4, 217-19(Mar-Apr 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 3, 39-41(Mar 1971).

Results concerning the effects of oxygen on the mechanical properties of Ti–2.5 V and Ti–2.5 V–3 Al alloys at room temperature are tabulated. Analysis of the results indicated that the presence of V in Ti alloys with Al and O imparts a high ductility. The values for ductility and fracture toughness remained high with up to 0.35% O. Larger amounts of O led to loss of ductility at room temperature as well as at negative temperatures. The microstructure of the heat affected zone in both Ti–2.5 V–0.3 O and Ti–2.5 V–3 Al–0.30 O consisted of α' phase, resembling martensite. It was concluded that the weldability of alloys with up to 0.5% O and 2.5 V and 3 to 3.5% Al are less sensitive to O and can be welded with oxygen concentrations up to 0.3% in the base metal. (P.C.H.)

2525 DIFFRACTION STUDY OF DIFFUSION IN THE Mo–Cr SYSTEM. Holloway, P. H.; Mohanty, G. P. (Florida State Univ., Tallahassee). J. Phys. Chem. Solids; 32: No. 11, 2656-9(Nov 1971).

A diffraction method was used to study diffusion in powder compacts, specifically the Mo–Cr system. Previous studies on the interdiffusion in this system are summarized. Source preparation and experimental and measurement details are given. No intermediate phase or any other deviations from complete solid solubility in Mo–50% powder compacts following successive diffusion anneals at 1050 or 1200°C were detected. (UK)

2526 STRENGTHENING AND CHANGES IN MICROSTRUCTURE DURING FATIGUE. Shetulov, D. I.; Sokolov, L. D.; Magidov, M. B.; Myasnikov, A. M.; Shibarov, V. V. Tr. Gor'k. Politekh. Inst.; 26: No. 8, 8-12(1970). (In Russian).

The fatigue strength and microstructure of specimens of commercially pure Al, Cd, Zn, Cu, Fe, and Ti were studied under conditions of cantilever rotational bending. Microstructural changes were determined metallographically, at stresses equal to the fatigue limit, after 10^4, 10^5, and 10^6 loading cycles. The slopes of the fatigue curves correlate with the stacking-fault energy value and increase with this value. During cyclic loading, materials with low stacking-fault energy strengthen more than those with high stacking-fault energies. (Referativnyi Zh.)

2527 VAPOR PRESSURE OF LIQUID URANIUM; EFFECTS OF DISSOLVED TANTALUM, PHOSPHORUS, SULFUR, CARBON, AND OXYGEN. Ackermann, R. J.; Rauh, E. G. (Argonne National Lab., Ill.). J. Phys. Chem.; 73: No. 4, 769-78(Apr 1969).

The vaporization behavior of liquid uranium saturated with tantalum, phosphorus, sulfur, and carbon was studied by mass effusion and mass spectrometric techniques in the temperature range 1800 to 2400°K. The results, combined with those previously reported for uranium saturated with oxygen, show that the activity coefficient of uranium decreases with increasing electronegativity of the dissolved component, varying from nearly unity in the case of tantalum and phosphorus to approximately 0.2 for oxygen. The vapor pressure of liquid uranium is given by the equation log $p(\text{atm}) = (5.71 \pm 0.17) - (25{,}230 \pm 370)/T$, and the heat of sublimation, ΔH°_{298}, is 126.3 ± 1.0 kcal/mol. At high temperatures uranium monophosphide and uranium monosulfide are converted to the two phase systems UP(s) + U(l) and US(s) + U(l). (auth)

2528 COBALT–IRON–TANTALUM HIGH-TEMPERATURE-STRENGTH ALLOY. Robertshaw, Fred C.; Bartos, Jon L. (to United States Atomic Energy Commission). U. S. Patent 3,607,249. 21 Sep 1971. Filed 20 Jan 1970.

The development and properties of a Co-base–Fe–Ta alloy for use in excess of 500°C and as high as 750°C are described. The alloy is characterized with a stable, face-centered cubic, crystallographic phase throughout the range of temperature from room temperature to melting, avoiding any difficulties involved in phase transformation. In addition, the alloy shows a favorable combination of short-term and high-temperature tensile strengths combined with excellent creep resistance as well as imparting an increased measure of hardness. (P.C.H.)

2529 THERMODYNAMIC PROPERTIES OF LIQUID ALLOYS OF URANIUM WITH CERTAIN RARE EARTH METALS. Bayanov, A. P. Sov. Radiochem. (Engl. Transl.); 12: No. 5, 735-7(Sep-Oct 1970).

Translated from Radiokhimiya; 12: No. 5, 768-71(Sep-Oct 1970).

The constants determining the energy of interatomic interaction of the components were found according to the data on the usual solubility of uranium and La, Ce, Pr, Nd, Sm, and Yb in the liquid state, using the theory of subregular solutions. The constants obtained were used to calculate the excess partial molar thermodynamic characteristics of cerium in uranium and of uranium in cerium at 1423 to 1523°K. (auth)

Structure and Phase Studies

Refer also to abstracts 2127 and 3151.

2530 DETECTING SEGREGATION IN TITANIUM ALLOYS. Baron, Donald J.; Snell, William A. (United Aircraft Corp.,

East Hartford, Conn.). Metal Progr.; 100: No. 2, 92-5(Aug 1971).

The method involves use of an acid salt solution for etching and anodization using trisodium phosphate solution followed by partial stripping of the oxide layer. The method can be used to reveal surface-connected segregation in Ti-6Al-4V and other Ti alloys. The test does not affect mechanical properties of the specimens. (J.R.D.)

2531 TECHNETIUM(VII) OXIDE: A TRANSITION METAL OXIDE WITH MOLECULAR STRUCTURE IN THE SOLID STATE. Krebs, Bernt (Univ., Goettingen, Ger.). Z. Anorg. Allg. Chem.; 380: No. 2, 146-59(Feb 1971). (In German).

Tc_2O_7 crystallizes in the orthorhombic space group Pbca with a = 13.756, b = 7.439, c = 5.617 Å, Z = 4. The single-crystal structure analysis shows the crystals to contain isolated centrosymmetric Tc_2O_7 molecules with a linear central Tc–O–Tc bridge and with tetrahedral coordination of the Tc atoms. Tc–O bond lengths are: 1.840 (bridge), 1.658, 1.684, and 1.706 Å. The structure is more closely related to CrO_3, RuO_4, and OsO_4 than to Re_2O_7. Structural properties of the d^0 transition metal oxides are briefly discussed. (auth)

2532 MECHANISMS OF SURROUNDING STRUCTURE FORMATION IN SINTERED TiC–Mo_2C–Ni ALLOY. Suzuki, Hisashi; Hayashi, Kozi; Terada, Osamu (Tokyo Univ.). J. Jap. Inst. Metals; 35: No. 9, 936-42(Sep 1971). (In Japanese).

A study was made of the mechanisms and the processes of formation of surrounding structure (s.s.) around TiC grains in sintered TiC–Mo_2C–Ni alloy. The partial 1300°C isothermal section of the quasiternary high-carbon alloy was studied. Referring to this diagram, metallographic studies mainly on the coarse-grained alloys having various compositions and sintered under various conditions were made in detail. Results obtained were as follows: (1) The formation of s.s. occurred through two or three steps, according to the alloy composition, sintering temperature and time, sintering method, etc. For instance, when the alloys with comparatively high contents of Mo_2C and Ni were sintered as usual, there could be observed three steps in the following order: the step of precipitation of Mo_2C–25% TiC solid solution (accompanied by the dissolution in particular of Mo_2C–2% TiC solid solution) on the surface of TiC grains; the step of solution-reprecipitation of s.s. and TiC core (bared as a result of dissolution of s.s.); and the step of precipitation during cooling. (2) Interdiffusions in or through the carbide phase during sintering seemed in general not to associate with the growth of s.s. and its composition changes. (3) Therefore, the s.s. generally consisted of two or three layers of different thickness and compositions. (auth)

2533 RELATION BETWEEN HEAT TREATED MICROSTRUCTURES AND THE EQUILIBRIUM DIAGRAM IN VARIOUS TITANIUM ALLOYS. Tokuda, Shoichi; Kawahara, Hiromichi (Kobe Steel, Ltd., Japan). J. Jap. Inst. Metals; 35: No. 9, 865-70 (Sep 1971). (In Japanese).

Seven commercial titanium alloys were classified according to the equilibrium diagram and metallography in comparing the β stabilizing degree which can be obtained from the results of x-ray diffraction and observations of the optical and electron micrographs (surface replica) under various heat treatment conditions. (1) The β stabilizing degree decreases in the order of Ti–13 V–11 Cr–3 Al, Ti–16 V–2.5 Al, Ti–4 Al–3 Mo–1 V, Ti–5 Al–2 Cr–1 Fe, Ti–6 Al–4 V, Ti–8 Al–1 Mo–1 V and Ti–5 Al–2.5 Sn. (2) In the classification of titanium alloys according to the equilibrium diagram and metallography, it seems most appropriate to classify the alloys into two kinds for the strong β stabilized alloys, two for the weak β stabilized alloys and one for α alloys, that is, five kinds all together. (auth)

2534 DIRECT OBSERVATION OF VOIDS IN DOPED TUNGSTEN BY SCANNING ELECTRON MICROSCOPY. Das, G. (IBM Components Div., East Fishkill, N. Y.). Met. Trans.; 2: No. 11, 3239-41(Nov 1971).

As-drawn doped powder-metallurgy tungsten wires were annealed at 1200°C for 30 min, fractured longitudinally, and examined in a scanning electron microscope. The microstructure (with resolution to 100 Å) consisted of polyhedral elongated grains fractured intergranularly, and circular dark features of size ranging between 100 and 1000 Å and lying along the wire axis. These circular voids are interpreted as voids. It is concluded that scanning electron microscopy can be used not only to identify voids, but also to determine their three-dimensional distribution. (D.L.C.)

2535 VERY PURE THIN-FILM TANTALUM PHASE. Schauer, A.; Peters, W.; Juergens, W. (Siemens AG, Munich). Thin Solid Films; 8: No. 3, R9-12(Sep 1971).

Studies were carried out on the deposition of β-Ta films in a sputtering apparatus using an electrodeless ring discharge and N_2 as the reactive gas component in the Ar sputtering atmosphere (10^{-3} torr). On glass substrates, a β–Ta film was produced every time, but on Ta_2O_5 substrates, a very pure α(bcc)-Ta film was formed under certain conditions. The results show that the criterion for the formation of β–Ta is a certain amount of residual gas in the film. The α–Ta is a very pure Ta, with a small resistivity (~25 μohm-cm) and a large positive coefficient of resistance (~1500 ppM/°C). If the upper limit of N_2 content for β–Ta is exceeded, bcc–Ta with a resistivity of 60 μohm-cm and a coefficient of 500 ppM/°C is formed. (D.L.C.)

2536 GADOLINIUM–CADMIUM SYSTEM. Bruzzone, G.; Fornasini, M. L.; Merlo, F. (Univ., Genoa). J. Less-Common Metals; 25: No. 3, 295-301(Nov 1971).

The gadolinium–cadmium equilibrium phase diagram has been established by differential thermal-, chemical-, metallographic- and x-ray analyses. Besides the already known intermediate phases (GdCd, $GdCd_2$, $GdCd_6$), three other compounds were found: $GdCd_3$ (Ni_3Sn-type), $GdCd_4$~ (γ-brass type), and Gd_2Cd_{9-x} ($Gd_{13}Zn_{58}$ or Pu_2Zn_{9-x}-type). No solid solubility range was observed around the intermediate phases. Only GdCd melted congruently (1170°C). Cd formed a solid solution with Gd, lowering the α–β transformation of the rare earth metal from 1238 to 725°C (at ~15 at. % Cd). Microhardness, density, and magnetic susceptibility were also measured on single phase specimens. (auth)

2537 STRUCTURAL STUDIES OF RARE-EARTH COMPOUNDS RFeAl. Oesterreicher, H. (Oregon Graduate Center, Beaverton). J. Less-Common Metals; 25: No. 3, 341-2(Nov 1971).

All light, rare earth compounds of a composition RFeAl showed a two phase region of the C15 type together with unidentified second phases, with the exception of LaFeAl which did not show the C15 type and may be a single phase material. All heavy, rare earth alloys, RFeAl, with the exception of YbFeAl, formed the hexagonal $MgZn_2$ (C14) type of structure. Structural parameters are tabulated. The observed intensities of C14 RFeAl materials were compared with the ones previously calculated for GdCoAl with statistical distribution of Co and Al on 2a and 6h sites and found that there were sizable deviations. (P.C.H.)

2538 YTTERBIUM–COPPER SYSTEM. Iandelli, A.; Palenzona, A. (Univ., Genoa). J. Less-Common Metals; 25: No. 3, 333-5(Nov 1971).

Crystallographic data are given for Yb–Cu compounds and also for $LuCu_5$ along with the phase diagram for Yb–Cu. Comparing the Yb–Cu system with the corresponding Yb–Ag and Yb–Au systems previously studied, some conclusions were drawn. The number of intermediate phases increased in passing from Cu to Ag and to Au (5,6,8 respectively); their compositions were rarely the same and only in a few cases were they isomorphous. The most interesting feature was the trivalency of Yb in some compounds of the Yb–Cu and Yb–Au systems. While in the case of Au the greater electronegativity could account for the trivalency of Yb, this factor could not apply in the case of Cu. Moreover, while in the Yb–Au system Yb became trivalent in the alloys richest in Au, this did not apply in the Yb–Cu system as the last compound, $YbCu_5$, again contained Yb(II). (P.C.H.)

2539 CRYSTAL STRUCTURE OF (Ho-, Er-, Tm-, Lu-, Y-)Zn_5 AND $ThCd_5$ INTERMETALLIC COMPOUNDS. Fornasini, M. L. (Univ., Genoa). J. Less-Common Metals; 25: No. 3, 329-32(Nov 1971).

Studies were made to complete the crystal structure determination of $ThCd_5$ and MZn_5 phases where M = Ho, Er, Tm, Lu, and Y. All the rare earth crystals showed a diffraction symmetry 6/mmm and a common hexagonal cell with lattice spacings a = 8.847, c = 9.177 Å. However, the patterns of crystals rotating around the z axis showed one additional layer line with very few weak reflections. The presence of this line led to the conclusion that a rhombohedral cell existed with a = 3 × 8.847 and c = 3 × 9.177 Å for some crystals and a hexagonal cell with a = 3 × 8.847 and c = 6 × 9.177 Å for others. The $ThCd_5$ compound also crystallized in the same type of structure as the MZn_5 phases. The coordination number of the rare earth atom (c.n.$_m$) was found to be 18. (P.C.H.)

2540 CONTROLLING CARBIDE DISPERSIONS IN NIOBIUM-BASE ALLOYS. Ostermann, F. (Leichtmetall Forschungsinstitut, Bonn). J. Less-Common Metals; 25: No. 3, 243-56(Nov 1971).

High-temperature strength of niobium-base alloys is most effectively achieved by a dispersion of fine, stable carbide phases. To control the degree of particle dispersion an understanding of the carbide precipitation behavior is required. For this purpose the sequence of decomposition reactions leading to the formation

of stable monocarbide dispersions in niobium alloys has been reviewed. Examples of experiments are given which illustrate how the uniformity of carbide dispersions can be controlled by a number of methods including special heat treatments, thermomechanical treatment, and alloy development. The question of carbide phase stability is briefly discussed, but much further work appears to be necessary to establish the factors which determine the long-time structural stability of carbide-strengthened niobium alloys. (auth)

2541 PRECIPITATION AND COARSENING OF SECONDARY-PHASE PARTICLES IN ALPHA URANIUM. Jovanovic, M. (Boris Kidric Inst. of Nuclear Science, Belgrade). J. Less-Common Metals; 25: No. 3, 237-42(Nov 1971).

The kinetics of the precipitation and coarsening of secondary-phase particles from a gamma quenched, dilute uranium alloy have been studied. The method of thin-foil electron microscopy was used. The precipitation from supersaturated solid solution at the onset of ageing was clearly distinguished from the subsequent process of coarsening. The values of the exponent, n, in the Avrami equation, together with metallographic evidence, indicate that precipitation on subgrain boundaries and on dislocations within subgrains occurred. Coarsening of particles can be best approximated by the equation $r^3 - r_0^3 = kt$. (auth)

2542 PHASE DIAGRAM OF THE COBALT–NIOBIUM SYSTEM. Bataleva, S. K. Vestn. Mosk. Univ., Ser. II. Khim.; No. 4, 432-7(1970). (In Russian).

The Co–Nb phase diagram was studied using microstructural, x-ray, thermal, and x-ray spectral analyses as well as hardness and magnetic-susceptibility measurements. Five intermetallic compounds exist in this system. Of these, the compounds $NbCo_2$ (homogeneous region Nb 27 to 34 at. %, λ_2 phase) and NbCo (homogeneous region Nb 49 to 56 at. %, μ phase) melt at a maximum of 1520 and 1430°C, respectively. The compound Nb_2Co_7 with homogeneous region 21 to 23 at. %, χ phase, is formed by a peritectoid reaction at 1050°C. The compound $NbCo_3$, λ_3 phase, which has effectively no region of homogeneity, forms at 1200°C by the peritectic reaction: liquid + $\lambda_2 \rightleftharpoons \lambda_3$. At 1000°C this breaks down eutectoidally to a mixture of $\chi + \lambda_2$. At 1420°C the λ_1 phase forms by a peritectic reaction, breaking down at 1200°C into a mixture of $\lambda_2 + \mu$ phases. Three eutectics crystallize in this system, i.e. β–Co (solid solution) + λ_3, $\lambda_1 + \mu$, and $\mu + \gamma$–Nb (solid solution) at 1210 and 1370°C respectively. The λ_1 and λ_2 phases belong to a family of Laves phases, the first has a $MgZn_2$-type lattice with a = 4.832 and c = 7.864 A and the second of $MgNi_2$-type with a = 4.735 and c = 15.456 Å. (Referativnyi Zh.)

2543 REDISTRIBUTION OF AN INTERSTITIAL SOLUTE IN A THERMAL GRADIENT. Marino, G. P. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 587-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2544 EFFECT OF CONCENTRATION HETEROGENEITIES IN THE ANALYSIS OF MATERIALS BY X-RAY FLUORESCENCE. Coladas, R.; Cizeron, G. (CEN de Saclay, Gif-sur-Yvette, France). Metaux (Corros.-Ind.); 46: No. 549, 191-202(May 1971). (In French).

Zr–Cu alloys containing between 0 and 3% Cu were studied. Concentration heterogeneities may occur during fabrication or heat treatments. Particular attention was given to the effect of ZrCu precipitates forming in these alloys. (France)

2545 THERMODYNAMIC STUDY OF THE URANIA–URANIUM SYSTEM. Ackermann, R. J.; Rauh, E. G.; Chandrasekharaiah, M. S. (Argonne National Lab., Ill.). J. Phys. Chem.; 73: No. 4, 762-9(Apr 1969).

The phase diagram (temperature-pressure-composition) for the uranium–oxygen system from 1600 to 2500°K in the composition range of the unvariant system UO_2(s) + U(l) was investigated in three steps. The composition of the urania phase in equilibrium with liquid uranium from 1900 to 2500°K was determined by an isopiestic method. The mole fraction of uranium dissolved in the UO_2 phase is given by $\log N_U = (1.63 \pm 0.11) - (6270 \pm 240)/T$. The total effusion rates were measured by means of the effusion method from 1580 to 2400°K. An "effective" vapor pressure p_e was calculated from the measured effusion rates, assuming the vapor to be UO(g). The least-squares treatment of the data resulted in the expression, $\log p_e(atm) = (7.25 \pm 0.15) - (27{,}020 \pm 250)/T$. The mass spectrometric investigation of the same system has shown the vapor to be predominantly UO(g) with smaller amounts of U(g) and UO_2(g). The temperature dependence and relative intensities of the species were measured mass spectrometrically and combined with the total effusion rates to yield the partial pressures for each species: $\log p_U(atm) = (5.21 \pm 0.14) - (25{,}640 \pm 300)/T$; $\log p_{UO}(atm) = (7.11 \pm 0.14) - (26{,}880 \pm 300)/T$; $\log p_{UO_2}(atm) = (7.74 \pm 0.14) - (30{,}180 \pm 300)/T$. The standard free energy of formation of UO(g) is given by the equation $\Delta G_f^\circ(UO) = -7800 - 13.8T$ (kcal/mol). (auth)

Radiation Effects

Refer also to abstracts 2031, 3103–3105, 3143, and 3152.

2546 (CEA-N-1093) STUDY OF THE COMPATIBILITY OF A MODEL OF THE BRINKMAN–SEEGER DAMAGE WITH THE RESULTS OF IRRADIATION OF STEEL. Lopez Jimenez, Jose (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr 1969. 52p. (In French). Dep. NTIS (U. S. Sales Only).

The compatibility of the Brinkman–Seeger damage model with the results of the irradiation of steel was studied. The results of the study comprise a partial confirmation of the damage model used. The evolution of the variation of the transition temperature as a function of the dose agreed with the formalism used. By taking into consideration the experimental imprecisions, the coefficient B was found independent of the type of irradiation reactor. The value of the coefficient C, independent of the type of steel used, was determined experimentally and was very close to the theoretical value predicted by the model. The effect of the irradiation temperature is apparent only for temperatures above 230°C. Above this temperature the coefficients B and C decrease and the model is not valid but can be used as an empirical formalism. The effect of thermal neutrons was not detected in the experiments which seems to indicate that the energy threshold for the formation of zones and dynamic crowdions is larger than the value retained. (tr-auth)

2547 (CEA-R-3986) STUDY OF AN APPARATUS FOR MEASURING THE ELASTIC PROPERTIES OF SOLIDS UP TO 1000°: APPLICATION TO IRRADIATED MATERIALS. Sorrentino, Francois (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jul 1971. 87p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Grenoble Univ. (France). Faculte des Sciences.

Equipment was developed for in-cell determination of the moduli of elasticity and internal friction of radioactive materials. Eigenfrequencies of cylindrical samples longitudinally vibrating with frequencies of about 10 kHz, were measured as a function of temperature between 10 and 1000°C. The internal friction was obtained by measuring the vibrational energy when the deformation remains constant. Such measurements were carried out with various materials: aluminum alloys, stainless steels and uranium carbides. (France)

2548 (HEDL-TME-71-110) SIMULATION OF SHORT-TERM ANNEALING OF DISPLACEMENT CASCADES IN γ-IRON. Doran, D. G.; Burnett, R. A. (Hanford Engineering Development Lab., Richland, Wash.). Aug 1971. Contracts AT(45-1)-1820; AT(45-1)-2170. 51p. Dep. NTIS.

The displacement cascades simulated by Beeler have been "temperature corrected" (to nominally 300 and 800°K) by means of a simulated short-term anneal. The annealing model was based on the simulation of γ-iron by Johnson. Results were obtained with both large (104 sites) and small (32 sites) annihilation regions (AR); the latter is considered the more realistic for the present model. In the high temperature simulation, it was found that the 104 site AR led to the survival of 2 interstitial-vacancy pairs/keV between 5 and 20 keV; 20 to 30% of the surviving interstitials and 40 to 60% of the surviving vacancies were clustered—the other defects migrated away and lost their identification with the cascade. Maximum interstitial cluster sizes were 8 at 20 keV and 5 at 5 keV. The maximum vacancy cluster size was 11 at both energies. The corresponding numbers for the small AR were ~4 defect pairs/keV; 35 to 50% of the interstitials and 60 to 70% of the vacancies clustered; and maximum interstitial cluster sizes were 10 and 8 and maximum vacancy cluster sizes were 22 and 12 at 20 and 5 keV, respectively. The number of clusters per cascade increased somewhat faster than the energy for both the large and small AR. The principal effect of randomizing the spatial distribution of defects in a typical cascade geometry was to diminish vacancy clustering and enhance interstitial clustering somewhat. In the low temperature simulation, the large AR led to 3.7 defect pairs/keV, and the small AR to 7 pairs/keV. In both cases, clustering of interstitials was more complete than in the high temperature simulation—only 10 to 14% of the interstitials remained single (and hence mobile)—although maximum cluster sizes (6 in each case) were smaller. The vacancy clusters suffered appreciable attrition causing the cluster size distributions to be shifted strongly toward small sizes. The high temperature,

large AR results are quite similar to those published previously in a simulated annealing of cascades in α-iron, but they show a somewhat lower production of large vacancy clusters. The present low temperature results differ from the low temperature α-iron results in that fewer interstitial clusters are produced and vacancy cluster attrition is lower in the present case. (auth)

2549 (UILU-ENG-71-60010) RELATIONSHIP BETWEEN MATERIAL FRACTURE TOUGHNESS USING FRACTURE MECHANICS AND TRANSITION TEMPERATURE TESTS. Technical Report No. 15. Corten, H. T.; Sailors, R. H. (Illinois Univ., Urbana. Dept. of Theoretical and Applied Mechanics). 1 Aug 1971. 78p. (T.A.M.-346). Dep. NTIS.

Based on the current state of the art, the toughness, K_{Id} of unirradiated and irradiated steel should be estimated in a conservative manner, using Charpy V-notch (C_v) data. In the temperature range of the upper shelf, the Rolfe-Novak relationship appears to give a reasonable and conservative estimate of K_{Ic} based on C_v energy data for unirradiated data. In the low and transition temperature range, K_{Id} should be estimated using an equation based on C_v energy data and compared with an estimate based on an equation using the drop weight NDT data. For irradiated steel, in the transition temperature range, an estimate of K_{Id} should be obtained by shifting the K_{Id} curve for unirradiated steel along the temperature axis by an increment ΔT measured in Charpy tests for unirradiated and irradiated specimens. These recommendations should be considered tentative because they are based on empirical correlations for a limited number of steels. A sound theoretical analysis of the elastic-plastic behavior and a fracture criterion is required to put these empirical relationships on a sounder basis for general use. (auth)

2550 CREEP LIMIT APPROACH TO THE DESIGN OF ZIRCALOY-2 REACTOR PRESSURE TUBES AT 275°C. Wood, D. S.; Watkins, B. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). J. Nucl. Mater.; 41: No. 3, 327 40(Dec 1971).

The design conditions for cold-worked Zircaloy-2 pressure tubes based on a creep limit approach are considered. A creep limit is adopted such that the time taken to reach this limit is no more than half of that taken to cause rupture. Out-of-reactor rupture tests of up to 4000 hr duration on 13-cm dia pressure tubes indicate that a 2% creep limit is reasonable at 275°C. Uniaxial in-reactor tests however give strains well in excess of out-of-reactor data; furthermore, none of the specimens failed. From these tests it is concluded that a pressure tube creep limit of 3% is reasonable. Latest reactor creep-rate data are shown to substantiate a relationship previously proposed in which the creep strain is shown to be a function of stress, temperature, flux level, and time. Using this relationship, times to reach specific creep strains are calculated for the commercial SGHWR pressure tube design conditions. (auth)

2551 EFFECT OF THERMOMECHANICAL TREATMENTS ON VOID FORMATION IN IRRADIATED STAINLESS STEEL. Stiegler, J. O.; Bloom, E. E. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater.; 41: No. 3, 341 4(Dec 1971).

An experiment was conducted to study the effects of dislocation density on the formation of voids in Type 304 stainless steel. Two specimens were cold-worked 10%; one was annealed, and both were irradiated in a fully annealed holder in EBR-II to a fluence of 2.5×10^{22} n/cm^2 (>0.1 MeV). The results show good agreement between calculated and measured void sizes and concentrations for the fully annealed stainless-steel holder. The irradiation reduced the void concentration and swelling, but the annealing (24 hr at 482°C and 100 hr at 700°C) restored the void concentration. Some possible reasons why very high dislocation densities retard swelling and moderately high densities enhance it are given. The role of helium is also discussed. (D.L.C.)

2552 DOSE DEPENDENCE OF VOID SWELLING IN A.I.S.I. 316 STAINLESS STEEL DURING 20-MeV C^{2+} IRRADIATION AT 525°C. Mazey, D. J.; Hudson, J. A.; Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 41: No. 3, 257-73(Dec 1971).

Fast neutron-induced void swelling has been simulated in both solution-heat-treated and 20% cold-worked type 316 austenitic stainless steel containing 10^{-5} He by irradiation at 525°C with 20-MeV carbon ions. Transmission electron microscopy was used to determine the volume swelling as a function of irradiation dose. Unlike the results for irradiated nickel, no swelling is observed in solution-treated 316 steel until a dose of ~2 displacements/atom; after this the swelling obeys a $(\text{dose})^2$ relationship up to ~40 displacements/atom where the swelling is ~5%. Above this dose, the swelling increases less rapidly and tends towards a saturation level of about 12% at 400 displacements/atom. This behavior is correlated with the evolution of dislocation structure and contrasted with that observed for nickel. The void distribution in cold-worked steel was inhomogeneous and the total swelling was lower by about a factor of two compared with solution-treated material. There is evidence for $M_{23}C_6$ carbide formation in the peak swelling region for ion doses above $\sim 6 \times 10^{17}$ ions cm^{-2} (i.e., ~80 displacements/atom). (auth)

2553 VOID FORMATION IN NICKEL DURING 20-MeV C^{2+} IRRADIATION AT 525°C. Hudson, J. A.; Mazey, D. J.; Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 41: No. 3, 241-56(Dec 1971).

Fast-neutron-induced voidage has been simulated in nickel using 20-MeV C^{2+} irradiations in the Harwell Variable Energy Cyclotron. Annealed nickel foils containing 10^{-5} He have been irradiated over the dose range $3 \times 10^{15} \rightarrow 3 \times 10^{18}$ ions/cm^2 at 525°C. A damage concentration versus depth calibration curve has been determined from an investigation by transmission electron microscopy of the swelling in specimens extracted from selected depths below the surface of the bombarded foils. The calibration curve was used to determine the swelling in nickel as a function of dose over the range 0.04 → 350 displacements/atom. Up to about 40 displacements/atom, the swelling increased linearly with dose to about 6%. Above this dose, the swelling increased more slowly, reaching about 15% at 350 displacements/atom. The void concentration varied between 5×10^{14} and 8×10^{15}/cm^3, and the swelling after any particular dose did not depend on the initial void concentration. In fact, the measured variation of swelling with dose is in good agreement with current theories of swelling in nickel which consider the growth of voids at a fixed concentration. (auth)

2554 TENSILE PROPERTIES OF IRRADIATED STAINLESS STEELS AND HIGH NICKEL ALLOYS. Ring, P. J.; Busboom, H. J.; Duncan, R. N. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 552-3(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2555 POSTIRRADIATION TENSILE DUCTILITY OF AISI TYPE 316 STAINLESS STEEL AT ELEVATED TEMPERATURES. Fish, R. L.; Holmes, J. J. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 553-4(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2556 1000-HOUR CREEP PROPERTIES OF 316 STAINLESS STEEL AFTER EBR-II IRRADIATIONS. Barker, R. W.; Lovell, A. J.; Holmes, J. J. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 554-5(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2557 IRRADIATION INSTABILITY OF COLD-WORKED TYPE 304 STAINLESS STEEL. Brager, H. R.; Straalsund, J. L. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 555(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2558 COMPARATIVE SWELLING OF VARIOUS AUSTENITIC ALLOYS. Appleby, W. K. (General Electric Co., Sunnyvale, Calif.); Busboom, H. J.; Wolff, U. E.; Duncan, R. N. Trans. Amer. Nucl. Soc.; 14: No. 2, 555-6(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2559 MECHANICAL PROPERTIES OF FAST REACTOR IRRADIATED AUSTENITIC STAINLESS-STEEL WELDMENT MATERIALS. Ward, A. L.; Blackburn, L. D.; Lovell, A. J. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 556-7(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2560 POSTIRRADIATION MECHANICAL PROPERTIES OF STANDARD AND TITANIUM-MODIFIED STAINLESS STEELS. Bloom, E. E.; Stiegler, J. O. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 557-9(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2561 CORRELATION OF IRRADIATION DATA WITH ACTIVATION FLUENCES AND IRRADIATION TEMPERATURE. Lynch, John H. (Plumb Brook Station, Sandusky, Ohio). Trans. Amer. Nucl. Soc.; 14: No. 2, 560-1(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2562 IRRADIATION PERFORMANCE OF ALUMINUM-BASE DISPERSION-TYPE FUEL PLATES. Martin, M. M.;

Richt, A. E.; Martin, W. R. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 567-8(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2563 IRRADIATION BEHAVIOR OF URANIUM ALLOYS WITH METASTABLE LATTICE STRUCTURES. McDonell, W. R.; Eberhard, B. J. (E. I. DuPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 568-9(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2564 CORRELATION OF IRRADIATION-PRODUCED CHANGES IN TENSILE AND FRACTURE PROPERTIES OF A533-B PRESSURE VESSEL MATERIAL. Hunter, C. W.; Williams, J. A. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 585-6(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2565 TEMPERATURE AND NEUTRON-SPECTRAL DEPENDENCE OF PRESSURE VESSEL STEEL EMBRITTLEMENT. Serpan, C. Z. Jr. (Naval Research Lab., Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 586-7(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2566 EFFECT OF CARBON ON IRRADIATION DAMAGE IN TITANIUM-MODIFIED HASTELLOY N. Sessions, C. E.; McCoy, H. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 602-3(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2567 EFFECT OF TEMPERATURE ON THE MICROSTRUCTURE OF NEUTRON-IRRADIATED TANTALUM. Wiffen, F. W. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 603(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2568 VOLUME CHANGES IN IRRADIATED TANTALUM. Bates, J. F.; Pitner, A. L. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 603-4(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2569 SWELLING IN REFRACTORY METALS DURING HIGH-TEMPERATURE ION BOMBARDMENT. Kulcinski, G. L.; Brimhall, J. L. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 604-6(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2570 EFFECTS OF CRYOGENIC IRRADIATIONS ON SELECTED PROPERTIES OF BERYLLIUM. DeMastry, J. A.; Merrick, T. P. (Westinghouse Astronuclear Lab., Large, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 606(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2571 EFFECT OF NEUTRON IRRADIATION AT 110°K ON THERMAL CONDUCTIVITY OF BERYLLIUM. Williams, J. M.; Hinkle, N. E.; Eatherly, W. P. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 606-7(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2572 BERYLLIUM FRACTURE TOUGHNESS AND THE EFFECTS OF IRRADIATION. Kesterson, R. L. (Westinghouse Electric Astronuclear Lab., Large, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 607(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2573 NEUTRONIC SENSITIVITY ANALYSIS OF MINIMIZING CORE-METAL SWELLING. Sha, W. T.; Huebotter, P. R. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 659-60(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2574 NUCLEAR DECAY HEATING OF TANTALUM IRRADIATED IN EBR-II. Straalsund, J. L.; Dahl, R. E. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 780(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2575 VOIDS IN NEUTRON-IRRADIATED ALUMINUM. Packan, Nicolas Hayes. Rolla, Mo.; Univ. of Missouri (1970). 159p. University Microfilms Order No. 71-22,394.
Thesis.
Void formation in high-purity aluminum resulting from fluences between 1.5×10^{19} and 1.6×10^{22} n/cm^2 (E > 0.1 MeV) at a temperature of 55 ± 5°C was studied by transmission electron microscopy. The effects of neutron fluence and flux were examined, as well as the possible influences of both preexisting and transmutation-produced impurities. A very low concentration of voids (about 10^{12}/cm^3) resulted from irradiation to 1.5×10^{19} n/cm^2; they averaged about 150 Å in diameter. Void concentrations and sizes increased with fluence, reaching values of 6×10^{14} voids/cm^3 averaging 500 Å in diameter at 1.6×10^{22} n/cm^2. Void formation initially was nonuniform in distribution, but tended to be homogeneous at higher fluences. The void shapes were always consistent with those of octahedra bounded by {111} planes, sometimes with the vertices truncated by {100} planes. Void size distribution curves were obtained for all fluences, and from these the mean void size was found to increase in proportion to the fluence raised to the one-sixth power. The void concentration displayed a fluence dependence best described by a power law, $N \sim (\phi t)^a$, in which the exponent decreased from 2 at 1.5×10^{19} n/cm^2 (E > 0.1 MeV) down to only 0.1 at 1.6×10^{22} n/cm^2. Treating the swelling with a similar power law, $\Delta V/V \sim (\phi t)^b$, a similar saturation effect was observed, with the fluence exponent b decreasing roughly from 2.5 to 0.5 over the range of fluence studied. At 1.6×10^{22} n/cm^2 the total void volume or swelling amounted to 7.4%. Microhardness increases in the irradiated specimens can be explained on the basis of void contributions to the impeding of dislocation motions. Irradiation at a factor-of-ten lower flux produced effects upon the void morphology (e.g., half as many but larger and more elongated voids) much like those resulting from irradiation at a higher temperature. In each case, the lowering of the vacancy supersaturation during irradiation is a consequence. Irradiation, annealing to remove damage, and reirradiation of a specimen, each exposure to a fluence of 5×10^{20} n/cm^2 (E > 0.1 MeV), yielded twice as many voids of smaller maximum size, having the same total void volume as those produced by the first irradiation alone. The effect is attributed to submicroscopic remnants of the original voids surviving the anneal and serving as preexisting nuclei in the second irradiation. In postirradiation void annealing experiments performed inside a high vacuum electron microscope, the rate at which void radius changed, dr/dt, varied considerably from void to void. A transient effect in dr/dt was observed upon abrupt changes in the annealing temperature. Both effects are ascribed to the actions of local vacancy sinks near the voids, such as a suggested population of submicroscopic gas bubbles. The experimental observations are compared with the current models for void formation. The two models most consistent with the experimental evidence both involve transmutation-produced helium playing a crucial role in void nucleation—one involving helium-stabilized spikes and the other small helium bubbles as the nuclei of voids. Throughout this work effects were found which demonstrate a strong influence of impurities upon void formation in high-purity aluminum. (Diss. Abstr. Int., B)

2576 EFFECT OF NUCLEAR RADIATION ON CORROSION CRACKING OF AMg6M ALLOY. Krast, Kh. B.; Byalobzheskii, A. V. At. Energ. (USSR); 31: No. 2, 151-3(Aug 1971). (In Russian).
Samples of AMg6M alloy 1.5 mm thick were placed under stress by being bent into a loop and then irradiated by neutrons in a reactor in order to determine the effect of the latter on corrosion cracking of the alloy. The temperature of all tests was 50 to 55°C; some samples were treated with a solution of NaCl, CH_3COONa, and CH_3COOH (pH = 5.15). The time to failure of the samples was recorded and it was noted that this time was sharply increased by radiation, as compared with controls. This is believed due to relaxation of the stress in the metal by the radiation. (K.S.W.)

Ceramics and Cermets

Corrosion and Erosion

Refer also to abstract 2450.

2577 (NYO-1710-104) KINETIC STUDIES OF THE OXIDATION OF HIGHLY ORIENTED PYROLYTIC GRAPHITE. Rodriguez-Reinoso, F.; Thrower, P. A.; Walker, P. L. Jr. (Pennsylvania State Univ., University Park. Dept. of Materials Science). [1971]. 21p. Dep. NTIS.
A highly oriented stress-recrystallized pyrolytic graphite has been used to study the kinetics of the carbon-O_2 reaction. Experimental conditions ranged from 700 to 800°C with O_2 pressures from 10 to 60 torr. Activation energies were found at 20 torr O_2 pressure and order of reaction determinations was made at 750°C. Prior to the reaction the specimen was outgassed at about 2×10^{-6}

torr for 8 to 12 hours at 950°C. The reaction was then followed by continuously monitoring the weight loss using a microbalance. An initially high transient oxidation rate was shown to be due to surface irregularities at the basal plane edges. Oxidation then occurred with an activation energy of 47 kcal/mole, which was shown to be due to the reaction of O_2 with C atoms at the edges of the graphite basal planes. There was no indication of the formation of a surface oxygen complex. The reaction order was found to have three values, in the range 0.6 to 0.9, depending on the manner in which the pressure was varied. The reason for this variation is not clear. (auth)

2578 (SC-R-69-1179) GRAPHITE TEMPERATURE AND ABLATION CHARACTERISTICS IN VARIOUS ENVIRONMENTS. Rindal, Roald A.; Dahm, Thomas J.; McVey, David F. (Sandia Labs., Albuquerque, N. Mex.). Jan 1969. 14p. (CONF-690119-2). Dep. NTIS.

From AIAA seventh aerospace sciences meeting; New York, N. Y. (20 Jan 1969).

Specification of experimental conditions for investigating ablation material performance requires consideration of simulation parameters such as enthalpy, pressure, heat transfer coefficient, and material surface temperature. With the exception of surface temperature, the desired values of each parameter may be compared to achievable values in ground test facilities with relative ease, but a simple, accurate means for establishing achievable surface temperature levels in various test facilities does not exist. Generalized results are presented for carbon (or graphite) surface temperature and ablation rate for a wide range of stagnation pressure, radiation heat flux, stagnation enthalpy, heat transfer coefficient, and test gas composition (air, nitrogen, helium, and argon). Certain examples are then presented which allow rapid evaluation of test facility capabilities in terms of achievable model surface temperature. (auth)

2579 CHARACTERIZATION OF UO_2 FUEL FROM A TEST-TO-FAILURE IN A TREAT FLOWING SODIUM LOOP. Murphy, W. F.; Dickerman, C. E.; Dewey, G.; Neimark, L. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 598 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2580 IN-PILE STEAM OXIDATION OF A MODEL HTGR FUEL ELEMENT. Freid, S. H.; de Nordwall, H. J.; Watson, G. M. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 780-1 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2581 METHOD AND APPARATUS FOR THE DISINTEGRATION OF FUEL ELEMENTS AND/OR BREEDER ELEMENTS. (to Kernforschungsanlage Juelich GmbH). British Patent 1,245,597. 8 Sep 1971. Priority date 23 Sep 1967, Germany.

Equipment and methods for disintegrating graphite coatings on fuel particles are described. Ferric chloride was used in reactions at 290 to 350°C with the graphite until coating disintegration is complete. (J.R.D.)

Preparation and Fabrication

Refer also to abstracts 2142, 2166, 2193, 2472, and 3834.

2582 (EUR-4699) DIRECT-GRAPHITE-RESISTANCE HEATED FLUIDISED BED: PRINCIPLES AND THERMAL PERFORMANCE OF A PILOT PLANT. Flamm, H. J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1971. 28p. Dep. NTIS (U. S. Sales Only). EUR FF 5.60.

A new high-temperature fluidized bed coating system has been devised and thermally tested, in which the graphite reaction chamber forms part of the resistance heater. The reaction chamber is coaxially placed in an outer part of the heater, having power connectors at the same (lower) end of the furnace for single phase operation. The "outer" heater—conveniently rated for lower heat generation—forms a graded thermal barrier with reduced heat losses from the "inner" reactor. Implicitly, heat generation per unit length of working zone can nearly be doubled. Comparative heating tests in a pilot unit suggest a reduction in power consumption of up to an estimated 50% over the conventional design, revealing not only considerable savings but also a possible route for retaining a graphite resistance heating system for large-scale operation. Coating experiment results showed no obvious effects on the electrical performance of the single phase system. In extrapolation of the experimental evidence a three-phase coaxial heater system, using the upper graphite-to-graphite contact as "star-point," is thought feasible. (auth)

2583 (IEA-190) FABRICATION OF FUEL ELEMENTS FOR RESEARCH REACTORS. de Souza Santos, Tharcisio Damy; Haydt, Heliton Motta; de Freitas, Clauer Trench; Gentile, Erberto Francisco; Capocchi, Jose Deodoro Trani; Cintra, Sebastiao Hermano Leite (Instituto de Energia Atomica, Sao Paulo (Brazil)). Oct 1969. 31p. (In Spanish). Dep. NTIS (U. S. Sales Only).

Results of studies of development and fabrication of fuel elements for research reactors are described. The studies comprised extensive experimental investigations concerning the metallurgical characteristics of UO_2, U_3O_8, and aluminum alloys. The development of the fabrication processes for fuel elements and the design and the construction of furnaces and equipment are described. Fuel element fabrication for the sub-critical assembly Re-Suco, consisting of natural UO_2 pellets packed in aluminum alloy tubes, and for the Argonaut reactor assemblies, consisting of plates containing enriched U_3O_8 at 19.91% ^{235}U dispersed in aluminum as core material, is described. Descriptions are also included on thin plates with 1.2-mm-thick with cermet cores; plates with Al-U_3O_8 cermets up to 75% U_3O_8; plates having four cermets; and aluminum-alloy clad plates with Al-U alloy cores. (auth)

2584 (NP-18996) TOKAI WORKS SEMI-ANNUAL PROGRESS REPORT, JANUARY-JUNE 1970. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. 98p. (N-831-70-2). Dep. NTIS (U. S. Sales Only).

Research and development programs are described on fuels, separation processes, nondestructive testing, fuel processing, radiation effects on fuels, and health and safety. (J.R.D.)

2585 (NUMEC-4281-1) DEVELOPMENT OF CONTINUOUS SINTERING OF LOW OXYGEN-TO-METAL RATIO MIXED OXIDE PELLETS FOR IMPROVED FAST BREEDER FUELS. Final Report. Ross, W. J.; Atkins, R. J.; Caldwell, C. S. (Nuclear Materials and Equipment Corp., Leechburg, Pa. Plutonium Lab.). Jul 1971. Contract AT(30-1)-4281. 178p. Dep. NTIS.

A program was carried out to develop conditions for continuous sintering of 21 and 26 wt % PuO_2-UO_2 fast breeder pellets to obtain an O/M ratio of $1.95^{+.01}_{-.02}$. The test variables included two levels of plutonium composition, two moisture levels, two sintering atmospheres and two types of additives for porosity formation. O/M ratios were obtained within the upper one-third of the desired range for test quantities of 1200 pellets (1.65 kg) at a continuous sintering rate of 400 pellets per hour. In these tests, the sintering furnace was operated at 1675 to 1720°C with $N_2-8\%$ H_2 and $Ar-8\%$ H_2 atmosphere containing 6 to 19 ppM H_2O and 7 ppM O_2. When the quantity was increased to 10,000 pellets (13 kg) at an average throughput rate of 500 pellets per hour, the average O/M ratio was found to be 1.962 for 21% PuO_2-UO_2 and 1.955 for 26% PuO_2-UO_2, when using $Ar-8\%$ H_2 + 1.5 ppM H_2O as the furnace atmosphere. Resintering reduced the O/M ratios to 1.957 and 1.953, respectively. Factors affecting the final sintered pellet oxygen-to-metal ratio were the quantity of pellets charged, the charging rate, the initial oxygen-to-metal ratio of the feed pellets, and the furnace gas moisture level. Tests were conducted using moisture levels derived from thermodynamic data and the O/M results support these general predictions. Two different pore-forming additives, carbowax and coprecipitated dried granules of $Pu(OH)_4$-ADU, were blended with the mechanically-mixed PuO_2-UO_2 feed powders for fabrication of low O/M ratio pellets to controlled densities of 90 to 92% T.D. Pellet dimensions, densities, and chemical compositions were generally controlled within the desired limits, except that sintering 21% PuO_2-UO_2 in $N_2-8\%$ H_2 gave nitrogen and total gas release levels above the maximum specified in RDT Standard E-13-6. (auth)

2586 (SC-T-713075) NEW METHODS OF OBTAINING METAL BORIDES. Cueilleron, J.; Lahet, G.; Thevenot, F.; Paris, R. A. Translated by Patricia Newman (Sandia Labs., Albuquerque, N. Mex.), from J. Less-Common Metals; 24: 317-22 (1971). 8p. Dep. NTIS.

Descriptions are presented of methods for the preparation of vanadium, chromium, iron, cobalt, and nickel borides by reaction between the mixture boron trichloride–hydrogen and metallic sulfides at 500 to 1000°C, the formation of the boride CrB_4 between 800 and 1000°C and the synthesis of titanium, vanadium, and chromium diborides by reaction of elementary boron with metallic sulfides at 700 to 1000°C. (auth)

2587 KINETIC MODELS FOR THE SYNTHESIS OF $(U,Pu)O_{2-y}$ BY HYDROGEN-REDUCTION AND CARBOTHERMIC TECHNIQUES. Lindemer, T. B.; Bradley, R. A. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater.; 41: No. 3, 293-302 (Dec 1971).

Three models were developed that permit the calculation of the time necessary for the synthesis of hypostoichiometric oxide from $(U,Pu)O_2$. The models are based on the interrelation between oxygen potential, valence of plutonium, and temperature determined by Rand and Markin and on the experimental conditions for reduc-

tion. Two reduction techniques are considered: the flowing hydrogen system and the $C-CO-CO_2$ system. At the usual temperatures for reduction, the partial pressure of water, the hydrogen flow, and the total weight of plutonia are the most important factors in the hydrogen system, while in the $C-CO-CO_2$ system the important factors are the weight of the plutonia in each oxide pellet, the partial pressure of carbon monoxide, the proximity of the oxide and the carbon used for reduction, and the oxygen-to-metal ratio possible at the oxygen potential of the $C-CO-CO_2$ equilibrium. (auth)

2588 CONTRIBUTION TO THE ENERGETIC STUDY OF COLD PRESSING OF UO_2 POWDERS. Stamenkovic, I. D.; Zivanovic, B. M.; Ristic, M. M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade. Univ. of Nis, Yugoslavia). Phys. Sintering; 3: No. 3, 157-65(Sep 1971).

Results of pressing experiments using a double-acting hydraulic press to compact UO_2 powders are described. It was found that the behavior of uranium dioxide powders during pressing is directly related to their physical properties. The total work of pressing was higher for powders having a larger surface area, as the result of their contraction. The pressing work dissipates on agglomerate fragmentation and the friction between particles amounts up to 30% of the total pressing work, mainly in the pressure range up to 3 ton cm^{-2}. In this pressure range the increase of compact surface area is the greatest. (J.R.D.)

2589 FORMING AND MACHINING ALUMINUM–BORON COMPOSITES. Weisinger, M. D. (General Dynamics Corp., San Diego, Calif.). Metals Eng. Quart.; 11: No. 3, 17-25(Aug 1971).

Several good methods for cutting and machining aluminum-boron composite material are available. Although diamond-coated tools make drilling, routing, and countersinking feasible, there is much room for improvement in the design and use of the tools. Removal rate, dimensional control, and finish produced by diamond tools are factors that should improve as development and application progress. Other machining processes such as abrasive cutoff, shearing, blanking, punching, and electrodischarge work well and are widely used. Bending a composite transverse to the direction of reinforcement is difficult, and no manufacturing ingenuity can alleviate the situation. Perhaps the newest and most spectacular forming method is high-pressure bonding—one of the few processes available to produce complex shapes from filament-reinforced metal-matrix material. Another process being investigated by several companies is tape consolidation by brazing. The process is sensitive to time, temperature, and pressure, but equipment and tooling costs are low. The high-pressure autoclave method, on the other hand, entails high initial equipment costs but is not sensitive to variations in process parameters. With the development of the newer tape-consolidation processes and the many processes now available for fabricating aluminum-boron sheet materials, the use of composite materials will expand into new fields of aerospace fittings, curvilinear configurations, and truss structures. (auth)

2590 PREPARATION OF Th_3N_4 AND Th_2N_2O. Kusakabe, Takao; Imoto, Shosuke (Osaka Univ, Suita, Japan). J. Jap. Inst. Metals; 35: No. 8, 795-800(Aug 1971). (In Japanese).

Th_3N_4 and Th_2N_2O were prepared, and their crystal structures and compositions were determined by x-ray diffraction patterns and chemical analysis. Th_3N_4 was prepared by heating Th metal powder at 1200°C in a nitrogen atmosphere of 1 mmHg to 1 atm. N/Th ratio of Th_3N_4 thus obtained was 1.28 to 1.36. X-ray diffraction powder pattern of Th_3N_4 showed a rhombohedral lattice structure with parameters of $a_0 = 9.405$ Å and $\beta = 23.723°$. Hexagonal Th_2N_2O($a_0 = 3.880$ Å, $c_0 = 6.180$ Å) was prepared by the reaction of 3 Th + ThO_2, 3 ThN + ThO_2, and Th_3N_4 + ThO_2 mixtures with 1 atm N_2 at 1200°C. According to x-ray lattice parameter data and the results of chemical analysis, the composition of the Th_2N_2O phase falls on a nearly stoichiometric range. (auth)

2591 METHOD FOR PREPARING STABLE URANIA–PLUTONIA SOLS. Tallent, Othar K. (to United States Atomic Energy Commission). U. S. Patent 3,600,323. 17 Aug 1971. Filed 6 Oct 1969.

A method for preparing stable urania–plutonia sols which exhibit minimal oxidation-reduction between the tetravalent ionic species is provided by preparing a nitrate-stabilized polymeric tetravalent plutonium sol by alcohol extraction of a plutonium nitrate solution, mixing the tetravalent plutonium sol with a crystalline, nitrate-stabilized, tetravalent uranium sol, and thereafter removing nitrate by solvent extraction. (Official Gazette)

2592 METHOD OF PRODUCING DENSE CARBON FROM ANTHRACENE. Wiley, Richard H. (to United States Atomic Energy Commission). U. S. Patent 3,600,291. 17 Aug 1971. Filed 28 Jan 1969.

A process is described for producing dense carbon products comprising exposing anthracene to coherent radiation of greater than 1.0 joule per millisecond. (Official Gazette)

2593 CURRENT STATE OF PRODUCTION TECHNIQUES FOR NUCLEAR FUELS IN JAPAN. Taketani, Kiyoaki (Japan Atomic Energy Research Inst., Tokai). Karyoku Hatsuden; 22: No. 3, 257-64(Mar 1971). (In Japanese).

The status of production methods for nuclear fuels for light-water reactors (primarily BWR and PWR) in Japan is discussed. Production processes and facilities for the purpose are satisfactory, and the quality control and inspection techniques are at a high level. Products also showed high performance in demonstration tests. Techniques for producing nuclear fuels includes conversion of UF_6 to UO_2 for light-water reactor use which predominates in this field. The fuel being fabricated is mainly UO_2 pellets enclosed in Zircaloy tubes. Fuel inspection methods are being studied at present. Demonstration tests of fuels for JPDR are described. By participating in the Halden Project, the development progresses steadily. As for test fuel assemblies, test results as well as their structure are described. (Japan)

2594 COMPOSITION OF THE GASEOUS PHASE OVER THE SYSTEM $B_4C-B_2O_3$. Derkach, V. D.; Gordienko, S. P.; Fenochka, B. V.; Epik, A. P.; Kolesnik, N. F. (Inst. of Materials Science, Kiev. Dnepropetrovsk Metallurgical Inst., Zaporozhe, USSR). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 4, 301-3(Apr 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 4, 58-60(Apr 1971).

During the heating of commercial boron carbide containing B_2O_3 in the temperature range 1173 to 1373°K, the boric anhydride was reduced to the lower oxide B_2O_2. In the temperature range investigated, no carbon oxides were formed during the reaction of the $B_4C + B_2O_3$ mixture. In the course of the vaporization of the system $B_4C-B_2O_3$, the B_2O_2 molecule content of the vapor increased with rise in temperature. (auth)

2595 DEVELOPMENT OF BONDING MATERIALS FOR HTGR FUEL ELEMENTS. Scott, J. L.; Coobs, J. H.; Hamner, R. L.; Robbins, J. M. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 566(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2596 DROP-FUSION METHOD FOR PRODUCING SPHERICAL FUEL PARTICLES FOR HTGR AND UHTREX FUEL ELEMENTS. Simnad, Massoud T.; Vanek, R. (Gulf General Atomic, San Diego, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 571(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2597 FABRICATION OF HELIUM PERMEABLE CERMETS FOR APPLICATION TO CURIUM FUELS. Martin, M. M.; Donnelly, R. G. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 576-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2598 MARK II FTR FUEL ASSEMBLY SODIUM FLOW TEST FABRICATION AND INSPECTION. Myers, R. L.; Blahnik, D. E. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 634-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2599 PROCESS FOR PREPARING LOW DENSITY SINTERED MATERIALS ESPECIALLY USED FOR CERAMIC FUEL MANUFACTURING. Dean, Guy (to Commissariat a l'Energie Atomique). French Patent 2,049,034. 26 Mar 1971. Filed 27 Jun 1969. (In French).

A process for preparing low-apparent-density sintered materials, especially sintered materials composed of uranium oxide or uranium plutonium double oxide, is presented. The process may also be used to prepare carbon based fuels or other ceramic fuels. It consists of first sintering the refractory powdered material with a grain size smaller than 30 μ, grinding the material obtained (grain size between 30 and 250 μ), and sintering a second time. (France)

2600 PROCESS FOR PREPARING RARE EARTH CHROMITE BASED CERAMIC MATERIALS AND THE MATERIALS OBTAINED. Elston, Jean; Roux, Madeleine (to Commissariat a l'Energie Atomique). French Patent 2,045,001. 15 Feb 1971. Filed 29 May 1969. (In French).

A rare earth chromite based ceramic material with a good electric conductivity at high temperature is presented. Particular applications are MHD converter electrodes and furnace heaters. It consists of a double chromite of two different elements from the group including the rare earths and Y. (France)

2601 PROCESS FOR PREPARING SINTERED PELLETS OF CERAMIC MATERIALS TO BE USED AS NUCLEAR FUELS AND PRODUCTS OBTAINED BY THE PROCESS. (to Comitato Nazionale per L'Energia Nucleare). British Patent 1,241,976. 11 Aug 1971. Priority date 4 Aug 1967, Italy.

A process is described for preparing sintered pellets of ceramic materials, such as U, Th, and Pu oxides, singly or in admixture with one another to be used as nuclear fuels. The sintered pellets have a specific surface area not greater than 4 m^2/g and a particle size smaller than 40 μ. The pellets are pressed without any preliminary mixing with binders and lubricants and then sintered in a non-oxidizing atmosphere free from hydrocarbons at a temperature in the range from 1150 to 1600°C for a period of from 1 to 8 hr. (P.C.H.)

2602 METAL IMPREGNATED GRAPHITE. Lanza, Franco; Marengo, Giuseppe (to EURATOM). British Patent 1,244,078. 25 Aug 1971. Priority date 13 Dec 1968, Netherlands.

A process is described for impregnating graphite with molten metal to produce an impermeable graphite suitable for use in nuclear reactors as a cladding material for fuel elements or as a structural material for making various parts of such a reactor. The graphite is heated at reduced pressure together with the selected metal to a temperature such that the metal melts. The graphite immersed in the molten metal is then placed under pressure (the bath is subjected to nitrogen under pressure), removed from the metal bath, and cooled. Bismuth is one of the substances mentioned as impregnating material. (P.C.H.)

2603 METALLOKERAMICHESKIE TVERDYE SPLAVY. (Metallo-Ceramic Hard Alloys). Romanova, N. I.; Chekulaev, P. G.; Dusev, V. I.; Livshits, T. A.; Kurdov, M. N. Moscow; Izdatel'stvo Metallurgiya (1970). 352p.

Principles of the production and application of metal-ceramic hard alloys are presented. Information is presented on the initial raw material. Methods are described for producing powders of metals and carbides used in the manufacture of hard alloys. Methods of grinding the initial materials and methods of preparing the mixtures and pressing them are described. Descriptions are given of processes occurring during sintering of alloys, and methods of treating hard alloy products. Areas of their application in the metal working and mining industries are described. Methods of quality testing of products during preparation of hard alloys are discussed. (JPRS)

2604 DISPERSION STRENGTHENING OF ALUMINUM ALLOYS BY REACTION OF UNSTABLE OXIDE DISPERSIONS. Hammond, Joseph P. (to United States Atomic Energy Commission). U. S. Patent 3,607,254. 21 Sep 1971. Filed 18 Oct 1968.

A method for preparing dispersion-strengthened metal consisting predominantly of aluminum metal as the metal matrix is provided comprising ball milling said metal as a powder with an unstable oxygen compound whose free energy of formation per gram-atom of oxygen at 500°C is less than that of the oxide of said metal matrix and which undergoes reaction with said metal matrix at said temperature to form a stable oxide dispersant in a hermetically sealed mill under an inert atmosphere in the presence of a grinding liquid. The resulting flake metal having homogeneous dispersion of the included oxide is then reacted in a nonoxidizing environment at a temperature of about 500°C, pressed, and hot extruded to form the dispersion strengthened product. Extruded bar material containing only 4 wt % oxide dispersant exhibited super elevated temperature strength when compared to conventional sintered aluminum product containing up to 15 wt % oxide dispersant. Another alloy showed improved low strain rate fracture ductility with good strength at high temperature when compared to sintered aluminum products. (Official Gazette)

Properties Evaluations

Refer also to abstracts 2134, 2503, 2511, 2513, 3136, 3139, 3147, 3156, 3161, and 3162.

2605 (GEAP-12210) THERMODYNAMIC DATA PROGRAM INVOLVING PLUTONIA AND URANIA AT HIGH TEMPERATURES. Quarterly Report No. 15, February 1–April 30, 1971. Aitken, E. A.; Adamson, M. G.; Evans, S. K.; Ludlow, T. E. (General Electric Co., Pleasanton, Calif. Nucleonics Lab.). Apr 1971. Contract AT(04-3)-189. 26p. Dep. NTIS.

Data related to vaporization of urania in urania–plutonia solid solutions, oxygen activities at high temperatures, oxygen redistribution in a temperature gradient, Pu/U segregation, and sodium-fuel interactions are included. (auth)

2606 (LA-4770) CMB-13 RESEARCH ON CARBON AND GRAPHITE. Report No. 17, Summary of Progress, February 1-April 30, 1971. Smith, Morton C. (Los Alamos Scientific Lab., N. Mex.). Sep 1971. Contract W-7405-eng-36. 27p. Dep. NTIS.

GRAPHITE—properties of extruded and hot-molded
—characteristics of commercial flours of
—composition and extrusion conditions for, containing resin binders
—properties of, containing furfuryl alcohol resin binders
—mechanical properties of, containing filler materials, effects of temperature on
—thermal expansion of tubes of
GRAPHITE SYSTEMS—graphite–ZrC, thermal conductivity of composites, calculated and measured
—graphite–ZrC, compositions and extrusion conditions for composites of
RESINS—properties for use as binders in extruded graphites
ZIRCONIUM CARBIDES—graphite–ZrC, compositions and extrusion conditions for composites of (R.C.K.)

2607 (LA-DC-12806) MEASUREMENT OF THE OXYGEN TO HEAVY METAL ATOM RATIO IN UNIRRADIATED MIXED-OXIDE FUELS. Metz, Charles F.; Dahlby, Joel W.; Waterbury, Glenn R. (Los Alamos Scientific Lab., N. Mex.). [1970]. 13p. (SM-149/33; CONF-711107-6). Dep. NTIS.

From Symposium on analytical methods in the nuclear fuel cycle; Vienna, Austria (29 Nov 1971).

The large amount of data that has been obtained by the different laboratories which have had extensive experience with the thermogravimetric method has led to the conclusion that differences as large as 0.02 in the O/M atom ratio are easily possible. These differences can be caused by variations in parameters such as the temperature of the adjustment treatment to a stoichiometric ($MO_{2.00}$) product, length of time of heating, and by the presence of moisture in the reducing gas. The pooled reproducibility of these measurements from seven laboratories is approximately 0.008, however, it has been observed to vary from 0.002 to 0.012 absolute standard deviation for individual laboratories. The accuracy, or bias, of this technique under a particular set of conditions is not known, a situation which arises from the lack of well-characterized materials with which to calibrate the methods. Recent information indicates that oxygen-deficient mixed oxides are unstable and tend to go slowly to $MO_{2.00}$ unless protected against oxygen. Failure to take this precaution in former comparisons might have been a significant factor affecting the values obtained. The greatest need at this time is to establish a sound experimental basis on which to answer the question of bias in any of the techniques used for this measurement. If this chemical property is as important as the analytical chemists have been led to believe, it is recommended that a study be made as to the feasibility of making available a set of characterized materials, standards if you will for purposes of method calibration and for an international sample exchange program. (auth)

2608 STUDIES IN THE SYSTEM UO_2–ThO_2–O_2. PART III. DILATOMETRIC AND HIGH TEMPERATURE X-RAY DIFFRACTOMETRIC STUDIES OF URANIUM OXIDES. Momin, A. C.; Mathews, M. D.; Karkhanavala, M. D. (Bhabha Atomic Research Centre, Trombay, India). Indian J. Chem.; 9: No. 6, 582-4(Jun 1971).

Thermal expansion measurements of uranium oxides in the composition range of $UO_{2.33}$ to UO_3 have been carried out in the temperature range of 25 to 850°C in air by dilatometric technique. The average linear expansion coefficient of $UO_{2.33}$ and UO_3 was positive in the respective stability range of 25 to 250°C, and 25 to 500°C, whereas U_3O_8 (stoichiometric and non-stoichiometric) showed an expansion anomaly in the range 25 to about 250°C, the average linear expansion coefficient being negative; above 250°C, it was positive. This anomaly has been verified by high temperature x-ray diffraction study of U_3O_8 up to 1000°C and was attributed to the transition of orthorhombic U_3O_8 at 210 ± 5°C to the hexagonal form. The c/a ratio of the hexagonal form was found to decrease gradually with increasing temperature in the range 400 to 1000°C. (auth)

2609 CARBONIZATION OF ZIRCONIUM OXIDE BY MEANS OF PLASMA JETS. Matsumoto, Osamu; Miyazaki, Takashi (Aoyama Gakuin Univ., Tokyo). Denki Kagaku; 39: No. 5, 388-93(May 1971).

The carbonization of zirconium oxide with graphite by heating with argon or argon–hydrogen plasma jet was studied. The plasma jet bombarded a tablet made of ZrO_2 and graphite powder that was set on a graphite anode. Metallic cake was formed on the anode by the reaction between ZrO_2 and graphite at high temperature. By x-ray diffraction method and chemical analysis, the cake was found to be ZrC, ZrO_2, zirconium, and graphite. Influ-

ences of the mixing molar ratio of graphite to ZrO_2, reaction time, and current intensity on the reaction were studied. From thermodynamic consideration and experimental results, the reaction may be written as follows: $ZrO_2 + 3C = ZrC + CO$. Zirconium carbide formed in this study was almost $ZrC_{1.00}$. (auth) (Japan)

2610 EQUILIBRIUM NITROGEN PRESSURES AND THERMODYNAMIC PROPERTIES OF URANIUM SESQUINITRIDE. Tagawa, H. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 41: No. 3, 313-19(Dec 1971).

Equilibrium nitrogen pressures over the two-phase region $UN + U_2N_3$ were measured between 750 and 1050°C. Nitrogen pressures were also determined in the single-phase region of U_2N_3. The U-rich phase boundary was obtained as 1.542 of the N/U atom ratio from the tensiometric measurement. The decomposition pressure of U_2N_3 was given by $\log p_{N_2}$ (atm) = 7.201 − 11736/T. The standard heat of the decomposition, $UN_{1.54} = UN + 0.27\ N_2$, was calculated to be $\Delta H^{\circ}_{298} = 16.74$ kcal/mole. (auth)

2611 USE OF THE Ni, NiO ELECTRODE AS REFERENCE ELECTRODE IN THE SOLID STATE GALVANIC CELLS CONTAINING URANIUM OXIDES. Marchidan, D. I.; Matei, Speranta (Inst. of Physical-Chemistry, Bucharest). Rev. Roum. Chim.; 16: No. 7, 1053-7(Jul 1971).

The electromotive force of the cells of the type: Ni,NiO |(0.85 ZrO_2 + 0.15 CaO)| uranium oxide was measured over the temperature range 1073 to 1373°K. From the measured values were calculated some thermodynamic properties of the uranium oxides having the atomic ratio O/U of 2.125 and 2.63; they were compared with the values of the same thermodynamic properties obtained in a previous work [Rev. Roum. Chim., 15: 149(1970)] with galvanic cells containing another reference electrode. (auth)

2612 THERMAL CONDUCTIVITY OF HIGHLY ORIENTATED PYROLYTIC BORON NITRIDE. Simpson, A.; Stuckes, A. D. (Univ. of Salford, Eng.). J. Phys., C (London); 4: No. 13, 1710-18(17 Sep 1971).

The thermal diffusivity of BN was measured from 100 to 800°K using a "flash" method, and published specific heat data were used to evaluate the thermal conductivity. Over a limited temperature range the results were confirmed by steady state measurements. The thermal conductivity parallel to the deposition plane was found to have a maximum value of about 2.5 W cm^{-1} K^{-1} at 235 K, while perpendicular to the plane the thermal conductivity showed no maximum, but decreased from about 2.5×10^{-2} W cm^{-1} K^{-1} at 100 K to 1.7×10^{-2} W cm^{-1} K^{-1} at 800 K. The conductivity parallel to the deposition plane was analyzed using a similar two-dimensional model to that developed by Kumatsu and Nagamiya (J. Phys. Lu. Japan 6: 438(1951)) for graphite, in which the vibrations in and out of the plane are independent and the latter depend only upon the resistance of the layer to bending. Characteristic temperatures for the two modes of 2290 K and 1200°K, respectively, were estimated. Above 200°K the conductivity can be explained in terms of Umklapp processes and boundary scattering from crystallites estimated to have average diameters in the deposition plane of 580 Å and 290 Å for the two samples investigated. The conductivity perpendicular to the deposition plane was also found to depend on both Umklapp processes and boundary scattering from very small crystallites, but their size was not estimated. (auth)

2613 REFRACTORY BORIDES AS THE MAIN CONSTITUENTS OF HARD-FACING POWDER MIXTURES. Gorbunov, A. E.; Bryksin-Lyamin, M. P. Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 4, 330-5(Apr 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 4, 91-7(Apr 1971).

It was established that tungsten borides in pure form are unsuitable for hard-facing applications. Mixed with Fe or Ni powder, they can be employed as the principal components of hard-facing materials. By changing the amount of the low-melting-point component (Fe or Ni) in a hard-facing mixture, it was possible to produce facing deposits having varying hardness and wear resistance values. Iron imparted higher hardness and wear resistance, and was therefore more effective as the low-melting-point component. It was established that tungsten boride contents in excess of 50% adversely affected the quality of facing deposits and increased their brittleness. Use of the tungsten boride W_2B_2 enabled facing deposits to be obtained having the more wear-resistant hypereutectic structure at a lower boride content. The crystals precipitated in hard-facing metal differed appreciably in microhardness from those of the pure borides WB and W_2B_2. It would appear that these crystals were either complex ternary borides having the composition $W_xFe_yB_z$ or the tungsten boride W_2B. (auth)

2614 ELECTRON WORK FUNCTION AND SURFACE RECOMBINATION OF HYDROGEN FOR ALLOYS OF THE SYSTEM HfC–WC. Denbnovetskaya, E. N.; Lavrenko, V. A.; Podchernyaeva, I. A.; (and others) (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 4, 289-91(Apr 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 4, 42-5(Apr 1971).

Alloys of the system HfC–WC were prepared by sintering, using the hot pressing technique, mixtures of metal powders and carbon black at a temperature of 2000°C and a pressure of 150 kg/cm^2 for 10 min. The specimens were then annealed for 5 hr at 1950°C in a vacuum of $\sim 10^{-4}$ torr. The curve of the effective work function of the alloys plotted against concentration showed two distinct regions. In the region of the single-phase HfC(CW) solid solution, ϕ_{ef} sharply increased with rise in WC content up to the composition corresponding to a WC content of 30 mole %; on passing to alloys richer in WC, this increase became less pronounced, and the work function of the alloys approached the value of ϕ_{WC}. The results obtained revealed the existence of a correlation between the work function (ϕ) and the coefficient of surface recombination of hydrogen atoms (γ) for the carbide alloys. An increase in ϕ was accompanied by a decrease in γ. (P.C.H.)

2615 ELASTIC PROPERTIES OF POLYCRYSTALLINE YTTERBIUM OXIDE. Powell, Bob R. Jr.; Hunter, Orville Jr.; Manning, William R. (Ames Lab., Iowa). J. Amer. Ceram. Soc.; 54: No. 10, 488-90(Oct 1971).

The sonic resonance technique was used to determine the elastic moduli of polycrystalline Yb_2O_3 samples of rectangular cross section ranging in pore fraction from 0.058 to 0.27 at temperatures from 25 to 1000°C. The data showed that the Young's and shear moduli are best related to pore fraction by a linear equation and to temperature by the Wachtman equation. The Debye temperature for Yb_2O_3 was calculated from the Young's and shear moduli to be 385°K. (auth)

2616 DISSOCIATION OF URANIUM OXIDES. Kulikov, I. S. At. Energ. (USSR); 31: No. 2, 93-8(Aug 1971). (In Russian).

Uranium forms the following oxides: UO, UO_2, U_4O_9, U_3O_8, and UO_3. Thermodynamic analyses based on the most accurate data obtained recently show that UO in the condensed state exists only below 877°K. UO_2 is the only congruent compound. The calculated boiling point of UO_2 is 3600°K. The total pressure of gaseous components over the $U-UO_2$ system is 1 atm at 3510°K. U_4O_9 forms a series of solutions with UO_2 at temperatures above 1500°K. The boiling points of solutions $UO_{2.33}-UO_2$ range from 2570 to 3600°K. U_3O_8 decomposes to U_4O_9 and oxygen (1 atm) at 1726°K, but the boiling point may be higher due to the formation of solutions between U_3O_8 and U_4O_9. UO_3 decomposes to U_3O_8 and oxygen (1 atm) at 1037°K. The gaseous phase over the condensed uranium dioxide contains UO_2, UO, and UO_3 and that over the $U-UO_2$ system contains mainly UO. The main component of the gaseous phase over higher uranium oxides U_4O_9, U_3O_8, and UO_3 is molecular oxygen. (auth)

2617 TRANSPARENT Sc_2O_3 BY HOT PRESSING. Gazza, G. E.; Roderick, D.; Levine, B. (Army Materials and Mechanics Research Center, Watertown, Mass.). J. Mater. Sci.; 6: No. 8, 1137-9(Aug 1971).

A commercially available Sc_2O_3 powder of 99.0 to 99.9% purity was dispersed in distilled water and subjected to ultrasonic treatment for 3 to 4 hr. The dispersion was then filtered and fired at 500°C in air for about 1 hr. The powder was cold pressed into a 25.4 mm diameter disc and placed into a graphite die in a vacuum hot press unit. After evacuation, the temperature was raised to 600°C and held for approximately 1 hr to permit out-gassing. A pressure of 4.6 Kg/mm^2 was applied and the temperature slowly raised to the hot pressing temperature (1500 to 1600°C). These conditions were maintained for 1 to 2 hrs and the specimen then allowed to cool slowly in the die. The specimens were found to be only translucent. An alternative procedure using an incremental heating cycle, which allowed full density (transparency) to be achieved by initially permitting diffusion of residual, volatile impurities to occur at temperatures where densification and grain growth occur slowly, produced transparent specimens. Microhardness measurements were made on polished transparent specimens giving an average value of 910 grams load. Optical transmission in the infrared region, grain size and fracture characteristics, modulus of rupture data, and elastic modulus were also measured. (UK)

2618 PLUTONIUM MIGRATION IN HIGH-TEMPERATURE MIXED-OXIDE FUEL. Demas, N. G. (Puerto Rico Water Resources Authority, San Juan); Natesh, R.; Maynard, C. W. Trans. Amer. Nucl. Soc.; 14: No. 2, 593(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2619 TRANSFORMATION TEMPERATURES OF IRRADIATED UO_2-PuO_2 FAST REACTOR FUELS. Reavis, J. G.; Green.

J. L. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 593-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2620 FABRICATION EFFECTS ON THERMAL CONDUCTIVITY OF MIXED-OXIDE FUELS. Lawrence, L. A.; Gibby, R. L.; Christensen, J. A.; Weber, E. T. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 598-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2621 BEHAVE-2: AN OXIDE FUEL PIN PERFORMANCE MODEL IN TWO SPATIAL DIMENSIONS AND TIME. Oldberg, S. Jr. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 629-31(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2622 SENSITIVITY OF FUEL PIN BEHAVIOR TO VOID SWELLING AND IRRADIATION CREEP OF STAINLESS STEEL. Boltax, A.; Soffa, T. P.; Biancheria, A. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 631-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2623 INFRARED STUDY OF GASEOUS UO AND UO_2 TRAPPED IN ARGON AND KRYPTON MATRICES AT LIQUID HELIUM TEMPERATURES. Leary, Herbert Joseph Jr. Iowa City, Iowa; Univ. of Iowa (1971). 135p. University Microfilms Order No. 71-22,113.

Thesis.

A urania–uranium mixture, pure $U^{16}O_2$ (s), and solid urania, 60% enriched in oxygen-18, were separately vaporized from tantalum Knudsen cells between 2300 and 2500°K. The urania cup used in the mixture experiments had been previously used in vapor-pressure experiments. The apparatus used for generating the vapors for the matrix isolation studies was attached to a time-of-flight mass spectrometer so that the effusing vapor could pass directly into the ionization chamber. The vapors produced were identified and isotopically analyzed mass spectrometrically prior to the matrix isolation studies, using the same apparatus. The mass spectral data indicated that U^+, $U^{16}O^+$, $U^{16}O^{18}O^+$, and $U^{18}O_2^+$ were present, that the relative intensity of U^+: UO^+: UO_2^+ was 0.4 : 5 : 1 at 2425°K and 15 eV in the mixture experiments, that the vapor in equilibrium with the enriched urania sample contained $^{18}O/^{16}O = 1.5 \pm 0.2$ and that the total relative intensity of U^+: UO^+: UO_2^+ was 0.03 : 1.2-1.5 : 1 at 2418°K and 20 eV. No TaO^+, TaO_2^+, or UO_2^+ were observed. The infrared data based on experiments from 4000 to 100 cm^{-1}, showed bands at 773 cm^{-1} (assigned to $U^{16}O$ in argon matrix), 734 cm^{-1} (assigned to $U^{18}O$ in argon matrix), 765 cm^{-1} (assigned to $U^{16}O$ in krypton matrix). Bands at 869 cm^{-1}, 853 cm^{-1}, and 825 cm^{-1} are thought to be associated with either the ν_1 or ν_3 fundamentals of $U^{16}O_2$, $U^{16}O^{18}O$ and $U^{18}O_2$, respectively, in argon matrix. The origins of bands observed at 769 and 726 cm^{-1} in the enriched urania experiments in argon matrix are presently unknown. Total absorption was observed from 100 to 50 cm^{-1}. The vibrational entropy, C , and free energy function at 298°K and 1 atm were calculated to be 0.2129, 0.6964, and 0.0483 cal deg^{-1} $mole^{-1}$ respectively for UO using 773 cm^{-1} for the UO frequency. (Diss. Abstr. Int., B)

Structure and Phase Studies

2624 (NP-tr-1937) INVESTIGATION OF THE STRUCTURE AND ELECTRICAL CONDUCTIVITY IN THE ZrO_2–Y_2O_3–Cu_2O, ZrO_2–Y_2O_3–Bi_2O_3, ZrO_2–Y_2O_3–Ni SYSTEMS. Kotlyar, A. G.; Neuimin, A. D.; Pal'guev, S. F.; Strekalovskii, V. N. Translated by S. Dobrianskyj (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: No. 3, 532-6(1970). 7p. Dep. NTIS (U. S. Sales Only).

Copper and bismuth oxides and metallic nickel were found to have low solubility in the $ZrO_2 + Y_2O_3$ mixture (90 : 10). Introduction of Cu_2O into the ZrO_2–Y_2O_3 mixture in amounts >5 mole % promoted electronic conduction depending on the conductivity of copper oxides distributed at the grain boundaries of ZrO_2–Y_2O_3 in the form of thin films, and formed direct bridges even with small additions. The electron constituent of conductivity in the $(ZrO_2 + Y_2O_3)$ + Ni mixtures appeared only for >40 wt % Ni. The electric conductivity of the 2-phase mixtures (solid solution ZrO_2–Y_2O_3 and Ni) was thus dependent on the frequency of the current passed through the specimen. (Australia)

2625 CUBIC OXYCARBIDES OF HAFNIUM. Alyamovskii, S. I.; Zainulin, Yu. G.; Shveikin, G. P.; Gel'd, P. V. Zh. Neorg. Khim.; 16: No. 6, 1480-4(Jun 1971). (In Russian).

An isothermal (1900°C) phase diagram was constructed for the system Hf–C–O, revealing a one-phase region of cubic oxycarbide HfC_xO_y small in extent and abutting the Hf–C side of the ternary diagram. The number of atoms which occupied an elementary cell of HfC_xO_y indicated that the cubic structure was characterized by unoccupied nodes both in the sublattice of the metal ($n_{Hf} < 4$) and in the nonmetal ($n_C + n_0 < 4$). A decrease in the lattice constants of HfC_xO_y with an increase of oxygen content was connected with the increase of vacancies in the Hf sublattice and an enhanced shielding of metal-to-metal bonds. (tr-auth)

2626 X-RAY STRUCTURAL INVESTIGATION OF THE SYSTEMS NIOBIUM–TITANIUM–BORON AND NIOBIUM–MOLYBDENUM–BORON. Kuz'ma, Yu. B. (Lvov State Univ.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 4, 298-300 (Apr 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 4, 54-7(Apr 1971).

Phase equilibria in the B–Nb–Ti system containing 66.7 at. % B confirmed the literature data of the existence of a continuous series of solid solutions between TiB_2 and NbB_2. The solubility of Ti in Nb_3B_4 attained 5 at. %, giving rise to a slight decrease in the lattice constants (a = 3.291, b = 14.07, c = 3.130 Å); TiB dissolved up to 5 at. % Nb, with virtually no change in its lattice constants. The compound NbB dissolved up to 30 at. % Ti. The solubility of Ti in Nb_3B_2 was less than 5 at. %. In the B–Mo–Nb system all niobium borides dissolved appreciable quantities of Mo. Replacing Nb by Mo invariably caused the lattice constants and the elementary cell volume to increase. The solubility of Nb in molybdenum borides was less. The existence of substantial fields of solid solutions based on NbB and NbB_2 at the temperature investigated suggests that continuous series of solid solutions may form between the isostructural compounds NbB_2–MoB_2 and NbB–β-MoB at other temperatures. (P.C.H.)

2627 RARE-EARTH PNICTIDES: THE ARSENIC-RICH EUROPIUM ARSENIDES. Ono, S.; Hui, F. L.; Despault, J. G.; Calvert, L. D.; Taylor, J. D. (National Research Council of Canada, Ottawa). J. Less-Common Metals; 25: No. 3, 287-94 (Nov 1971).

Differential thermal analysis and x-ray powder diffraction techniques have been used to examine the arsenic-rich, europium–arsenic binary system in the temperature range 600 to 1200°C. The phases EuAs, Eu_3As_4, Eu_5As_3, $EuAs_2$, and $EuAs_3$ have been characterized by powder techniques and, in addition, single crystal measurements have been carried out for Eu_3As_4, Eu_5As_3, and $EuAs_3$. EuAs, Eu_3As_4, Eu_5As_3, $EuAs_2$, and $EuAs_3$ decomposed peritectically at 900, 950, 930, 912, and 800°C, respectively. An additional phase Eu_5As_{3+x} ($x \simeq 0.05$) was stable between 697 and 842°C. EuAs had a distorted NiAs structure of the Na_3O_3 type, $P\bar{6}2m$, a = 8.1575 Å, c = 6.1378 Å; the remaining phases appeared to be of new structure types, Eu_3As_4, Fdd2, had a = 14.6438 Å, b = 17.6416 Å, c = 5.8857 Å, Eu_5As_3 was monoclinic, P*/*, a = 14.1058 Å, b = 5.9559 Å, c = 12.3250 Å, β = 90.74°; $EuAs_2$ was orthorhombic P***, a = 7.1433 Å, b = 6.9195 Å, c = 6.0486 Å; $EuAs_3$ was monoclinic, C*/*, a = 9.500 Å, b = 7.591 Å, c = 5.789 Å, β = 112.62°. (auth)

2628 INFLUENCE OF DYNAMIC CALCINATION ON CRYSTALLITE GROWTH OF SUBMICRON RARE-EARTH OXIDES. Mazdiyasni, K. S. (Air Force Materials Lab., Wright-Patterson AFB, Ohio); Brown, L. M. J. Amer. Ceram. Soc.; 54: No. 10, 479-83(Oct 1971).

The crystallite growth of rare earth oxide powders with particle sizes of 10 to 30 Å obtained by the hydrolytic decomposition of alkoxides was investigated. These powders were compared with commercially available powders with average particle sizes from 1000 Å to 10 μm. Static and dynamic atmosphere tests were made, the latter by continuous tumbling during calcination. Dynamic calcination controlled crystallite growth effectively while maintaining uniform particle size. Typical arithmetic mean particle sizes were 250 Å for powders calcined at 800°C for 24 hr with tumbling and ≈400 Å for powders calcined under identical conditions without tumbling. TGA, x-ray diffraction, and emission spectrographic analyses were used to characterize the powders. Electron microscopy and BET surface area measurements demonstrated the importance of the dynamic calcination method in the growth of primary crystallites into larger particles during the presintering stage of the processing of these powders. (auth)

2629 HIGH TEMPERATURE STUDY OF THE STOICHIOMETRY, PHASE BEHAVIOR, VAPORIZATION CHARACTERISTICS, AND THERMODYNAMIC PROPERTIES OF THE LANTHANUM + OXYGEN SYSTEM. Ackermann, R. J.; Rauh, E. G. (Argonne National Lab., Ill.). J. Chem. Thermodyn.; 3: No. 4, 445-60(Jul 1971).

The lanthanum + oxygen system was studied by investigating the

vaporization behavior of the sesquioxide phase as a function of temperature and composition, employing mass effusion and mass-spectrometric techniques. The partial pressures of LaO(g) over the sesquioxide phase were measured in the presence of tungsten (1933 to 2408°K) and in the presence of rhenium (1778 to 2427°K). The former were greater by 40 to 80%. The congruently vaporizing composition began to depart from stoichiometry with increasing temperature and at 2400°K reached values of $La_2O_{2.900\pm0.002}$ in tungsten and $La_2O_{2.898\pm0.002}$ in rhenium, demonstrating a slight reducing effect on rhenium and a measurably greater reducing effect of tungsten. Data on thermochemical quantities are given. The partial pressures of La(g) and LaO(g) over the liquid metal + sesquioxide were measured over the temperature range 1516 to 1904°K. The composition of the sesquioxide phase at the lower phase boundary was determined as a function of temperature from 1660 to 1925°K and appeared to depart from the stoichiometric value above 1400°K. At 1925°K the sesquioxide was reduced to $La_2O_{2.82}$. The standard Gibbs free energy of formation of the substoichiometric oxide at the lower phase boundary was evaluated as a function of temperature; a calculated value of −282.9 kcal mole^{-1}, corresponding to the composition $La_2O_{2.83}$, was about 16 kcal mole^{-1} less negative than that of the stoichiometric sesquioxide. The standard Gibbs free energy change for the isomolecular reaction, La(g) + YO(g) = LaO(g) + Y(g), was redetermined and compared with the dissociation energies of the monoxides evaluated from the thermochemical data. (auth)

2630 CERMETS IN PHASE DIAGRAMS. Ondracek, G. (Kernforschungszentrum, Karlsruhe, Ger.); Splichal, K. Ber. Deut. Keram. Ges.; 48: No. 8, 343-54(Aug 1971). (In German).

A review of cermets as ceramic-metal-composites is presented. Reasons are given for subdividing these materials into stable and unstable combinations. A comment is made about the calculation of the number of possible cermets in multicomponent systems. An arrangement of the more than 100 binary phase diagrams containing cermets known from the literature is included. As an example the calculation of an eutectic-type phase diagram with a very narrow range of terminal solid solution is considered. Thermochemical assessments are also made to decide which stable combinations should be formed by interaction of the phases of unstable cermets using Fe_3C–U-cermets as an example. (auth)

2631 STUDY OF THE POLYMORPHISM OF URANIUM OCTOXIDE AND TRIOXIDE UNDER HIGH PRESSURE. Tsvigunov, A. N.; Kovba, L. M.; Kudin, O. V.; Zubova, E. V. Sov. Radiochem. (Engl. Transl.); 12: No. 6, 813-16(Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 843-7(Nov-Dec 1970).

A study of the phases of α-U_3O_8 and γ-UO_3 at high pressure and temperature is reported. For α-U_3O_8 in the entire range of pressures from 20 to 80 kbar at 20°C two phases were present, αU_3O_8 and β-U_3O_8. Above 200°C no β-U_3O_8 was detected. (D.H.M.)

2632 PHASE EQUILIBRIA IN THE SYSTEM MnO–FeO–ZrO_2–SiO_2. Shultz, R. L.; Muan, Arnulf (Pennsylvania State Univ., University Park). J. Amer. Ceram. Soc.; 54: No. 10, 504-10(Oct 1971).

Phase equilibrium relations in the liquidus temperature region of the system MnO–FeO–ZrO_2–SiO_2 and of its bounding systems MnO–ZrO_2, MnO–ZrO_2–SiO_2, and MnO–FeO–ZrO_2 were determined by the quenching technique. The equilibrations were carried out at sufficiently low O_2 pressures to keep most of the Mn and Fe in divalent states. The results obtained were combined with literature data for the other bounding binary and ternary systems to present phase diagrams showing liquidus surfaces and interrelations between coexisting liquid and solid-solution phases. Applications of the data to refractory problems are discussed. (auth)

2633 X-RAY DIFFRACTION POWDER PATTERN OF METASTABLE CUBIC ZrO_2. Katz, Gerald (Israel Mining Industries Ltd., Haifa). J. Amer. Ceram. Soc.; 54: No. 10, 531(Oct 1971).

The metastable cubic and metastable tetragonal phases of ZrO_2 were encountered in studying the dehydration of $Zr(OH)_4$. The hydroxide was dried at 110°C and heated in a platinum crucible from 24 hr periods at successively higher temperatures. At 285°C the metastable cubic phase appeared. At 300°C the splitting of some of the cubic lines indicated the onset of the transformation to the metastable tetragonal form. At 320°C the stable monoclinic form began to appear together with the metastable tetragonal form. From 600°C upward only the monoclinic form was detected. The x-ray diffraction pattern of the metastable cubic form was characterized by broad diffuse diffraction lines, indicating the very fine crystallite size of the chemically precipitated material. (P.C.H.)

2634 BEHAVIOR OF FISSION GAS BUBBLES IN MIXED-OXIDE FUEL. Michels, L. C.; Makenas, B. J.; Poeppel, R. B. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 581-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Radiation Effects

Refer also to abstracts 2031, 2189, 2562, 3132, 3851, and 3852.

2635 (GA–10699) IRRADIATION-INDUCED DIMENSIONAL CHANGES OF H-327 FUEL ELEMENT GRAPHITE. Cobb, H. R. W. (Gulf General Atomic Co., San Diego, Calif.). 9 Sep 1971. Contract AT(04-3)-633. 36p. Dep. NTIS.

Samples of production-grade H-327 fuel element graphite were irradiated in six capsules at fast fluences and temperatures which cover the proposed service conditions of the material in the Fort St. Vrain High-Temperature Gas-Cooled Reactor. This material exhibited no observable changes in structural integrity at fast neutron fluences of 8 to 9×10^{21} n/cm^2 (E > 0.18 MeV). Furthermore, when fabricated in the current HTGR fuel block configuration, the material will not experience expansion in the radial direction within the proposed range of service conditions. Damage gradients due to variations in radial fluence and the stress relaxation effects that result are discussed in terms of a creep constant for the material which is shown to be similar to the broad band values derived for all graphites. (auth)

2636 (RCN–151) POST-IRRADIATION EXAMINATION AND MODE OF FAILURE OF THE DUTCH FUEL ASSEMBLY IFA-103, IRRADIATED IN THE HALDEN BOILING WATER REACTOR. van der Linde, A. (Reactor Centrum Nederland, Petten). Apr 1971. 119p. Dep. NTIS (U. S. Sales Only).

Three out of seven fuel pins in the IFA-103 test assembly failed after operation in the Halden Boiling Water Reactor. Post-irradiation examination of the longitudinally cracked, Zircaloy-2 clad fuel pins revealed that in two of the failed pins the tantalum tube, incorporated in the center of the vibrationally compacted fuel stack, was locally attacked. Moreover, one of these pins had a top weld which was deformed from the inside by a stainless steel spring during welding. The formation of Zr–Fe–Cr and Zr–Fe–Ni eutectics in the heat affected zone of the cladding resulted in hair cracks and a blistered ring on the outer surface. Although these phenomena contributed to the severity of the clad failures, the primary action resulting in the first clad fracture was attributed to a local fuel-clad reaction. It was found that at sites where a fuel particle was pressed firmly against the inner clad wall, oxygen and, when present in the pin interior, also hydrogen was quickly in the cladding. This phenomenon resulted in the formation of a sunburst; a spherical zone around the fuel-clad contact which was enriched in oxygen and depleted in hydrogen. This sunburst, as observed at room temperature, was surrounded by radially oriented hydrides. Absorption of oxygen resulted in local deterioration of clad ductility properties so that in combination with the increase in stress imposed on the cladding by the expanding zirconium lattice, small radial cracks were formed. Propagation of these primary cracks occurred via stress oriented, radial hydrides towards the outer surface up to a point where the remaining clad wall failed ductile by necking and 45° angle fracturing. The post-irradiation examination results are discussed in relation to this fracturing mechanism. (auth)

2637 OBSERVATION OF He BUBBLES FORMED IN SLIGHTLY IRRADIATED B_4C PELLET. Suzuki, Hiroshige; Yoshida, Hiroshi; Kimura, Shiushichi (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 7, 408-9(Jul 1971).

The distribution of bubbles of He in irradiated B_4C pellets and their migration during high temperature annealing were examined by means of electron microscopy using the replication method. The pellets of B_4C hot-pressed to a theoretical density of more than 99% were used. It was found that the migration of He has been accelerated by high temperature, resulting in bubbles as large as 1μ in diameter. Such a progressive migration of He bubbles appears to substantiate the report that He release from irradiated B_4C pellet becomes very marked at 2,000°C. (J.R.D.)

2638 SELF-RADIATION DAMAGE IN ^{244}Cm OXIDE AND ALUMINATE. Mosley, W. C. (Savannah River Lab., Aiken, S. C.). Contract AT(07-2)-1. J. Amer. Ceram. Soc.; 54: No. 10, 475-9(Oct 1971).

Self-radiation from α-decay of ^{244}Cm caused lattice swelling, phase transformations, and loss of structure in several Cm compounds. In Cm oxides, the percentage swelling at saturation decreased with decreasing symmetry: Swelling in fluorite (fcc) CmO_2 (≈0.3%) was approximately twice that in bcc C-type Cm_2O_3; monoclinic Cm_2O_3 did not swell. CmO_2 swelled with time according to $\Delta\alpha/\alpha = 3.0 \times 10^{-3}(1 - e^{-1.7\times10^6\lambda t})$, essentially the same relation

as for PuO_2 and AmO_2. The rate of structure loss of Cm oxides decreased with increasing temperature of prior heatings. In $CmAlO_3$ the metamict state was produced before swelling reaches saturation. Radioinduced transformation at room temperature produced metastable phases that normally existed at higher temperatures, e.g., bcc C-type Cm_2O_3 transformed to hexagonal A-type Cm_2O_3, and rhombohedral $CmAlO_3$ became cubic. (auth)

2639 IRRADIATION OF MOLYBDENUM-URANIUM DIOXIDE CERMET FUEL PINS AT 1600°F TO 5.3 PERCENT BURNUP. McDonald, Glen E. (Space Nuclear Systems Office, Cleveland). Trans. Amer. Nucl. Soc.; 14: No. 2, 566-7(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2640 IRRADIATION BEHAVIOR OF URANIUM-SILICIDE FUELS AT HIGH POWER. Feraday, M. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Chomski, C. D.; Cotnam, K. D.; Morel, P. A. Trans. Amer. Nucl. Soc.; 14: No. 2, 569-70(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2641 TRANSIENT IRRADIATION EFFECTS ON MECHANICAL AND THERMAL BEHAVIOR OF PuO_2 MICROSPHERES. Evans, S. K.; Aitken, E. A. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 570-1(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2642 IRRADIATION PERFORMANCE OF BORON CARBIDE POWDERS CONTAINING FREE BORON. Copeland, G. L.; Donnelly, R. G.; Martin, W. R. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 573(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2643 FAST REACTOR IRRADIATION OF BORON CARBIDE POWDER. Pitner, A. L. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 573-4(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2644 CALCULATIONS ON THE IN-PILE BEHAVIOR OF FISSION GAS IN OXIDE FUELS. Ronchi, C.; Matzke, Hj. (EURATOM, Karlsruhe, Ger.). Trans. Amer. Nucl. Soc.; 14: No. 2, 580(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2645 IRRADIATION-INDUCED RE-SOLUTION OF FISSION GASES IN OXIDE FUELS. Pati, S. R. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 580-1(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2646 SWELLING OF UO_2-PuO_2 IN THE EQUIAXED GRAIN GROWTH REGION. Hilbert, R. F.; Storhok, V. W.; Chubb, W.; Keller, D. L. Trans. Amer. Nucl. Soc.; 14: No. 2, 582-3(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2647 HIGH POWER AND HEAT FLUX IRRADIATION OF URANIUM-PLUTONIUM CARBIDES. Montgomery, M.; Strasser, A. (Gulf United Nuclear Fuels Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 594-5(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2648 EVALUATION OF SODIUM-BONDED URANIUM-PLUTONIUM CARBIDE FUEL RODS IRRADIATED TO 46,000 MWd/T. Montgomery, M.; Grando, C.; Strasser, A. (Gulf United Nuclear Fuels Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 595-6(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2649 SOL-GEL SPHERE-PAC $(U,Pu)O_2$ FUEL PERFORMANCE IN EBR-II IRRADIATION TESTS. Olsen, A. R. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 596-8(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Plastics and Other Materials

Refer also to abstract 2943.

2650 (TID-25793) AN EXPERIMENTAL APPROACH TO THE STUDY OF THE CREEP BEHAVIOR OF PLAIN CONCRETE SUBJECTED TO TRIAXIAL STRESSES AND ELEVATED TEMPERATURES. Research Report Number 2864-1. Kennedy, Thomas W.; Perry, Ervin S. (Texas Univ., Austin. Dept. of Civil Engineering). Jun 1970. 228p. Dep. NTIS.
For Oak Ridge National Lab., Tenn.

An experimental investigation of the creep behavior of concrete which had a nominal 28-day compressive strength of 6000 psi and which was typical of the type of concrete which is used in prestressed concrete reactor vessels is described. The experiment consisted of measuring the axial and radial strains in 6 × 16-inch cylindrical specimens subjected to 58 test conditions involving triaxial compressive stresses ranging from zero to 3600 psi, two curing histories in which the concrete was either air-dried or sealed, two temperatures during the loading period (75 and 150° F), and three curing periods prior to loading (90, 183, and 365 days). After curing, the specimens which were cured for 90 days were subjected to load for a period of 12 months followed by a 5-month unloading period during which creep recovery was observed; the specimens cured for 183 and 365 days were not unloaded, however, and will remain under load for an indefinite period of time. All specimens were sealed while under load to prevent moisture exchange. Creep strains were estimated by taking the difference between the time-dependent strains in the loaded specimens and in unloaded companion specimens. In addition, 6 × 12-inch cylindrical specimens were prepared in order to obtain an estimate of the compressive and tensile strengths of the concrete for the various test conditions throughout the test period. The design of the experiment and all procedures associated with the casting, curing, sealing, and loading of the specimens are described in detail. In addition, a description of the equipment which was designed and built specifically for this investigation is included. (auth)

2651 (TID-25794) EXPERIMENTAL INVESTIGATION OF CREEP IN CONCRETE SUBJECTED TO MULTIAXIAL COMPRESSIVE STRESSES AND ELEVATED TEMPERATURES. Research Report Number 2864-2. York, Guy P.; Kennedy, Thomas W.; Perry, Ervin S. (Texas Univ., Austin. Dept. of Civil Engineering). Jun 1970. 428p. Dep. NTIS.
For Oak Ridge National Lab., Tenn.

Preliminary findings in an investigation performed to evaluate the effects of five major factors and their interactions on creep in plain concrete are reported. Factors investigated included temperature during loading (75 and 150° F), curing history described as air-dried and as-cast, axial loads in combinations of five stress levels varying from 0 to 3600 psi, radial loads in combinations of five stress levels varying from 0 to 3600 psi, and time which consisted of a continuous observation period of 18 months after casting. The experiment consisted of applying compressive loads along the three principal axes of cylindrical concrete specimens. Loads along the longitudinal axis were varied independently of loads applied along the radial axes, permitting triaxial, biaxial, and uniaxial states of stress to be evaluated. The loads were applied by means of a hydraulic loading system and strains were measured by vibrating wire strain gages cast in the concrete along the axial and radial axes. The creep strains were analyzed statistically through two factorial designs within the experiment. Analysis of variance was used to evaluate effects such as two- and three-factor interaction effects, and the nonlinear effects of stress and time. The highly significant effects are discussed in detail and the less significant effects are identified. Also included is a discussion of the effects of factors on creep Poisson's ratio and creep recovery. Several equations which predict creep strains were developed through regression analysis, employing all factors investigated. (auth)

2652 (TID-25795) APPROACH TO ESTIMATING LONG-TERM MULTIAXIAL CREEP BEHAVIOR FROM SHORT-TERM UNIAXIAL CREEP RESULTS. Research Report Number 2864-3. Chuang, John W.; Kennedy, Thomas W.; Perry, Ervin S. (Texas Univ., Austin. Dept. of Civil Engineering). Jun 1970. 137p. Dep. NTIS.
For Oak Ridge National Lab., Tenn.

An investigation of the creep behavior of concrete subjected to multiaxial stresses ranging from 0 to 3600 psi, two different temperatures during loading (75 and 150° F), and two different curing histories (sealed and air-dried) is described. Equations for estimating creep strains in the principal directions for stresses less than the creep proportional limit are derived by establishing a linear time-dependent relationship between creep strain and stress from uniaxial creep tests and by assuming that concrete is a homogeneous, isotropic body and that the application of the law of superposition to creep strain is valid. On the basis of the experimental results it appears that these assumptions are reasonably valid. A comparison of measured creep strains with calculated creep strains indicated that when the stress level was

less than the creep proportional limit, the predictive equations provided a satisfactory estimate of the actual creep strains. The standard errors of estimate for the sealed and air-dried curing conditions at 75°F were 16 and 27 micro-units and at 150°F were 33 and 40 micro-units. The concept of introducing creep strain into stress-strain analyses of concrete is considered and discussed together with effective modulus of elasticity, time-dependent flexibility, and time-dependent lateral expansion per unit stress of concrete. (auth)

2653 HOW RADIATION AFFECTS PLASTICS. Bohm, Georg G. A.; Oliver, William F.; Pearson, Dale M. (Firestone Tire and Rubber Co., Westbury, N. Y.). Soc. Petrol. Eng. J.; 27: 21-5(Jul 1971).

Radiation processing of polyethylene, polyvinylidenefluoride, and polyvinylchloride was examined. It is noted that these polymers can be modified by radiation—the most notable changes occurring in their properties at elevated temperatures. Those changes can be optimized by a careful consideration of key parameters. (J.R.D.)

2654 RATE OF DAMAGE OF POLYMER CRYSTALS IN THE ELECTRON MICROSCOPE: DEPENDENCE ON TEMPERATURE AND BEAM VOLTAGE. Grubb, D. T.; Groves, G. W. (Oxford Univ.). Phil. Mag.; 24: No. 190, 815-28(Oct 1971).

Irradiation in the electron microscope causes many changes in crystalline polymers, but the most easily measurable of these is the change in the diffraction pattern from single crystals. It was found that the intensity of a {1010} reflection from a polyoxymethylene single crystal decays exponentially after a short period, of reproducible duration, when the form of decay is variable. The intensity of all electrons emerging from the column except those associated with the directly transmitted beam behaves in the same way. The period of variable decay corresponds to the period when diffraction contrast remains visible on the dark-field image. The decay of diffraction from polyethylene is more complex because radiation damage produces long-range disorder in the lattice, and this is accompanied by motion of the crystal, even when it is firmly supported on a carbon film. Measurement of these decay curves provided the basis for comparison of radiation damage rates at different beam voltages and different specimen temperatures. Cooling to 18°K decreased the damage rate of polyethylene by a factor of 3, and did not affect that of polyoxymethylene. Changing the beam voltage between 30 and 125 kv affected all specimens in the same way: the damage rate was proportional to (electron velocity)$^{-2}$. (auth)

2655 RADIATION EFFECTS ON PSEUDOSTABLE MATERIALS FOR LONG-TERM SPACE MISSIONS. Varsi, Giulio Q. (California Inst. of Tech., Pasadena). Trans. Amer. Nucl. Soc.; 14: No. 2, 549-51(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

PHYSICS (GENERAL)

Astrophysics and Cosmology

Cosmic Ray Exposure Ages

Refer also to abstract 2341.

2656 ISOTOPIC RATIO OF LITHIUM IN CHONDRITE MEASURED BY AN ION PROBE MASS SPECTROMETER. Nishimura, Hiroshi; Okano, Jun (Osaka Univ.). Jap. J. Appl. Phys.; 10: No. 11, 1613-22(Nov 1971).

Isotopic abundance ratios of lithium, $^{7}Li/^{6}Li$, for four stony meteorites and for a terrestrial granite sample, G-1, were measured by an ion-probe mass spectrometer. The measured ratios for the meteorites were about 13% lower than the ratio for G-1. The results were inconsistent with those obtained by conventional mass spectrometers with surface ionization ion sources at other laboratories. The mass discrimination effects and the systematic errors, which may lower the measured ratios preferentially for the meteorites, were thoroughly investigated in connection with the characteristics of the ion-probe mass spectrometer. The origin of the instrumental bias however, was not found. Although further experimental work with both types of mass spectrometer should be required to reach the final conclusion, the difference is likely existent from the results. (auth)

2657 ISOTOPIC COMPOSITION OF ^{244}Pu FISSION XENON IN METEORITES: REEVALUATION USING LUNAR SPALLATION XENON SYSTEMATICS. Podosek, F. A.; Huneke, J. C. (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett.; 12: No. 1, 73-82(Sep 1971).

The isotopic composition of fission xenon in four meteorites (Pasamonte, Kapoeta, Angra dos Reis, and St. Severin) was reevaluated. Spallation corrections were made by means of spallation systematics based entirely on lunar data, with explicit allowance made for variations in the spallation xenon spectrum at different temperatures in thermal degassing experiments. The resulting best estimate of the fission Xe composition in St. Severin, Kapoeta, and Pasamonte was $^{128}Xe/^{129}Xe/^{130}Xe/^{131}Xe/^{132}Xe/^{134}Xe/^{136}Xe = 0/\lesssim 10/\equiv 0/25/85/91.5/\equiv 100$. (auth)

2658 ASSAM: A GAS-RICH HYPERSTHENE CHONDRITE. Schultz, L. (Federal Inst. of Tech., Zurich); Signer, P.; Pellas, P.; Poupeau, G. Earth Planet. Sci. Lett.; 12: No. 1, 119-23 (Sep 1971).

Concentrations and isotopic compositions of He, Ne, and Ar as well as track densities due to galactic and solar flare irradiations were determined in light and dark fractions of the L-chondrite Assam. The investigation showed Assam to be a gas rich dark–light structured hypersthene chondrite. Two percent of the L-group chondrites are now known to contain solar light noble gases (H-group: 12%, LL-group: 8%). (auth)

2659 ^{40}Ar–^{39}Ar AGES AND COSMIC-RAY-EXPOSURE AGES OF APOLLO 14 SAMPLES. Turner, G.; Huneke, J. C.; Podosek, F. A.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett.; 12: No. 1, 19-35(Sep 1971).

The $^{40}Ar-^{39}Ar$ dating technique was used on eight samples of Apollo 14 rocks (14053, 14310), breccia fragments (14321), and soil fragments (14001, 14167). The large basalt fragments give reasonable $^{40}Ar/^{39}Ar$ release patterns and yield well-defined crystallization ages between 3.89 and 3.95 aeons. Correlation of the $^{40}Ar/^{39}Ar$ release patterns with $^{39}Ar/^{37}Ar$ patterns showed that the low-temperature fractions with high radiogenic argon loss came from K-rich phases. A highly shocked sample and fragments included in the breccia yield complex release patterns with a low-temperature peak. The total argon age of these fragments is 3.95 AE. Cosmic-ray exposure ages on these samples are obtained from the ratio of spallogenic ^{38}Ar to reactor-induced ^{37}Ar and show a distinct grouping of low exposure ages of ~26 my correlated with Cone crater. Other samples have exposure ages of more than 260 my and identify material with a more complex integrated cosmic-ray exposure history. (auth)

Stars

2660 RADIATIVE TRANSFER EFFECTS ON THERMAL-CONVECTIVE INSTABILITY IN HYDROMAGNETICS. Bhatia, P. K. (Univ. of Jodhpur, India). Bull. Soc. Roy. Sci. Liege; 40: No. 3-4, 137-41(1971).

The effects of radiative transfer on the convective instability of a thermally unstable stellar atmosphere in the presence of uniform rotation and a uniform magnetic field are discussed. The criterion for monotonic instability is found to be the same as in the absence of these effects. (auth)

2661 PERIODIC LAW AND MODERN PHYSICS. Zel'dovich, Ya. B. Vestn. Akad. Nauk SSSR; No. 1, 35-9(Jan 1970). (In Russian).

The buildup of the elements from protons, neutrons, and electrons to form the periodic table is reviewed, and the extension of the table to element 105 is discussed. In dense stars the forces of gravitation holds matter together, and a dense electron gas is achieved in stellar interiors. In this state, energetic electrons react with protons to form neutrons; thus, neutron stars, which may be regarded as one vast nucleus, are formed. The hydrogen–^{4}He–^{12}C–heavy nuclei chain is referred to in stellar evolution. The achievements of Gell-Mann and of several Soviet scientists are touched upon. (K.S.W.)

2662 LIGHT CURVE AND PHOTOMETRIC ELEMENTS OF THE VARIABLE RT COMA BERENICES. Pop, Vasile (Astronomical Observatory, Cluj). Stud. Cercet. Astron.; 16: No. 1, 33-7(1971). (In Rumanian).

Using Guilleminot plates with 10-min exposures, 342 observations were recorded from 1964 to 1969. The construction of a mean curve from the normal points yielded the following limits of variation of the luminosity: $m_{max} = 13.41$ and $m_{mip} = 14.64$. Observations made on the maximum established the following light variation: max. hel. = D. J. 2,440,023.3841 + 0.5651762. Analysis of the light curve and the asymmetry values indicate that RT Coma Berenices is of the type RR Lyrae, subclass RR_a. (tr-auth)

2663 ELEMENTS OF THE ECLIPSING BINARY SW LACERTAE. Dumitrescu, Alex; Dinescu, Rodica (Astronomical Observatory, Bucharest). Stud. Cercet. Astron.; 16: No. 1, 55-60 (1971). (In Rumanian).

The elements of the eclipsing binary SW Lacertae, type W UMa, were calculated. Photoelectric observations of the V system only from the Observatoire Haute Provence in 1965 were employed. (tr-auth)

2664 DETERMINATION OF THE KINEMATIC PARAMETERS OF B STARS. Filin, A. Ya. Byull. Inst. Astrofiz., Akad. Nauk Tadzh. SSR; No. 50, 30-7(1970). (In Russian).

Determination of the kinematic parameters of B0 to B5 stars from the radial and tangential velocities of the stars was considered. Components of the parallactic motion of the stars, Oort's constants, parameters of the velocity ellipsoid, and certain other kinematic constants were determined. (IAA)

2665 INVESTIGATION OF ELEVEN CEPHEIDS. Satyvaldiev, V. Byull. Inst. Astrofiz., Akad. Nauk Tadzh. SSR; No. 54, 21-35(1970). (In Russian).

Characteristics of a group of 11 Cepheids were analyzed according to photographs obtained at the Institute. Previous observations of jumpwise variations of periods in BY Cas and SZ Tau were confirmed. A jumpwise variation of the period was also established in HBV 404. The elements of DX Gem were improved. (IAA)

2666 THEORY OF THE INTERACTION OF STARS WITH COOPERATIVE MOTIONS OF THE STELLAR GAS. Marochnik, L. S. Byull. Inst. Astrofiz., Akad. Nauk Tadzh. SSSR; No. 50, 3-15(1970). (In Russian).

The equations describing the interaction between stars and cooperative motions of the stellar "gas" were derived. A comparative analysis was made of the situations prevailing in a plasma and in gravitation. An indication of the applicability of the equations obtained is presented on the basis of an evaluation of the terms discarded in their derivation. Both linear and nonlinear corrections due to these terms were considered. (IAA)

2667 PRESENCE OF ^{3}He IN THE PHOTOSPHERE OF RHO LEONIS. Wallerstein, George (Univ. of California, Berkeley). Publ. Astron. Soc. Pac.; 83: No. 495, 664-6(Oct 1971).

From measurements on 17 spectrograms no evidence was found for the ^{3}He previously reported to be present in ρ Leonis. The profile of Hα was found to show emission on one occasion and to be extremely broad and shallow at another time. (auth)

2668 CARBON STARS WITH STRONG ^{13}C AND LITHIUM SPECTRAL FEATURES. Gordon, Courtney P. (Hampshire Coll., Amherst, Mass.). Publ. Astron. Soc. Pac.; 83: No. 495, 667-73(Oct 1971).

The spectral characteristics of the type J subclass of carbon stars are described and the positive correlation between strong ^{13}C and lithium features is noted. Four new members of this class are listed. The average temperature of this group is similar to that of late R stars, although the spread is considerable. The photometric colors are anomalously red. The strength of the Merrill–Sanford bands and of characteristic features of this group are not correlated. The $^{12}C/^{13}C$ ratio appears to be exceptionally low. Spallation and neutron irradiation probably produce the lithium and the ^{13}C. (auth)

2669 HALF-WIDTHS OF STELLAR Hα PROFILES DEDUCED FROM SPECTROGRAMS OBTAINED WITH THE McMATH SOLAR TELESCOPE. LoPresto, James Charles (Michigan Univ., Ann Arbor). Publ. Astron. Soc. Pac.; 83: No. 495, 674-6(Oct 1971).

Profiles of Hα were obtained photoelectrically for some late-type stars. The relationship between the absolute magnitude and the half-width of the Doppler core of Hα is better established than that with the half-width of the total profile found by Kraft, Preston, and Wolff in 1964. (auth)

2670 MINIMA AND LIGHT ELEMENTS OF V 453 CYGNI. Cohen, Howard L. (Univ. of Florida, Gainesville). Publ. Astron. Soc. Pac.; 83: No. 495, 677-9(Oct 1971).

Old unpublished times of minima light of V453 Cygni and new photoelectric times of minima light are presented. The observations show that the light elements published in A Finding List for Observers of Eclipsing Variables appear to be slightly in error and that secondary minimum is displaced from one-half period. The new light elements are Min. I = JD2439340.0988 + 3.8898128dE with Min. II occurring at phase 0.5077P. The measured value of $e \cos \omega$ is +0.012. It is most probable that $270° < \omega \leq 360°$ and $e < 0.02$. These photometric elements are discordant with Pearce's spectroscopic elements, especially P, Te, and ω. The spectroscopy of V453 Cyg should therefore be re-evaluated. (auth)

2671 DISTANCE TO BL LACERTAE. Pigg, J. C.; Cohen, M. J. (California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac.; 83: No. 495, 680-2(Oct 1971).

The 21-cm absorption spectrum of BL Lacertae indicates that it is more than 200 pc, and possibly less than 2 kpc ($z = -350$ pc) distant. Arguments are presented for the position that the data are consistent with BL Lac's being extragalactic. (auth)

2672 RADIAL VELOCITY OF 60 SERPENTIS. Abt, Helmut A.; Levy, Saul G. (Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac.; 83: No. 495, 687-8(Oct 1971).

Coudé measures of this K0 III star do not confirm the published evidence that it is a single-lined spectroscopic binary with a period of three days. (auth)

2673 γ CORVI AND THE ROTATION OF THE Hg–Mn STARS. Cowley, Anne; Cowley, Charles (Univ. of Michigan, Ann Arbor). Publ. Astron. Soc. Pac.; 83: No. 495, 689(Oct 1971).

γ Corvi is shown to be a Hg–Mn star with moderate rotation making the detection of the peculiar features difficult. (auth)

2674 RADIATION FROM PARTICLES FALLING INTO BLACK HOLES. Ross, D. K. (Iowa State Univ., Ames). Publ. Astron. Soc. Pac.; 83: No. 495, 633-7(Oct 1971).

The electromagnetic radiation emitted when a charged particle falls into a neutral Schwarzschild black hole is calculated. For zero angular momentum fall, a system of N electrons emits $\sim 10^{43}$ times as much electromagnetic radiation as gravitational radiation. This ratio is reduced for particles with a larger mass-to-charge ratio than the electron. For particles in a spiraling circular orbit the energy emitted is the same in the charged and uncharged cases, but the spiral time is much shorter for a charged particle. The linearly falling or orbiting charged particle represents a new radiation mechanism for black holes. The spiral time for uncharged particles of physical interest emitting gravitational radiation is found to be prohibitively long. Such processes, discussed in the literature, essentially never take place. (auth)

2675 EVOLUTION OF SUPER-HELIUM-RICH 2-SOLAR-MASS STARS. Liebert, James W.; Allen, Christine; Schweizer, Francois; Tarter, Jill (Univ. of California, Berkeley). Publ. Astron. Soc. Pac.; 83: No. 495, 626-32(Oct 1971).

Evolutionary calculations are presented for three $2M_{\odot}$ configurations, two having super-helium-rich compositions, (X,Y,Z) = (0.30, 0.69, 0.01) and (0.30, 0.695, 0.005), and one a moderately helium-rich composition (0.60, 0.39, 0.01). The Z = 0.005 configuration is evolved past core helium exhaustion, the others only past core helium ignition. Neither super-helium-rich star passes through a significant convective-envelope (Hayashi) phase, either before or after core helium ignition. Both stars become substantially brighter after shell hydrogen ignition and after core helium ignition. The configuration evolved through core helium exhaustion becomes very blue (up to $T_e = 56{,}800°K$) and very bright ($M_{bol} \sim -5$). The structural evolution of these models is discussed with regard to general ideas on post-main-sequence evolution. Observable features of a hypothetical super-helium-rich cluster are also indicated. (auth)

2676 MASSES OF THE HORIZONTAL-BRANCH STARS IN M67. Bond, Howard E. (Louisiana State Univ., Baton Rouge); Perry, Charles L. Publ. Astron. Soc. Pac.; 83: No. 495, 638-42(Oct 1971).

Four-color Strömgren photometry shows that the "blue-straggler" and "horizontal-branch" stars in the old galactic cluster M67 do not have low surface gravities and that they are more massive than the cluster stars at the main-sequence turnoff. Therefore, they are not highly evolved single stars but most probably close-binary systems in various stages of evolution with mass transfer, as suggested by McCrea. (auth)

2677 RADIAL VELOCITIES AND SPECTRAL CLASSIFICATION OF A-TYPE STARS NEAR THE SOUTH GALACTIC POLE. Bond, Howard E. (Louisiana State Univ., Baton Rouge); Perry, Charles L.; Bidelman, William P. Publ. Astron. Soc. Pac.; 83: No. 495, 643-7(Oct 1971).

Radial velocities and spectral types are listed for over 100 A-type stars in the region of the south galactic pole (SGP). Comparison of published photometry with intrinsic color indices derived from the spectral types yields a small but significant interstellar reddening at the SGP of $E(B-V) = 0.03M$. (auth)

2678 FURTHER OBSERVATIONS OF HD 193516. Lee, Paul (Louisiana State Univ., Baton Rouge). Publ. Astron. Soc. Pac.; 83: No. 495, 648-9(Oct 1971).

Additional observations of the suspected β Cephei star HD 193516 are presented. No statistically significant variations were found. (auth)

2679 UBV OBSERVATIONS OF SELECTED DOUBLE SYSTEMS. III. Landolt, Arlo U. (Louisiana State Univ., Baton Rouge). Publ. Astron. Soc. Pac.; 83: No. 495, 650-1 (Oct 1971).

UBV magnitudes and color indices were obtained for 17 double systems listed in the Catalogue of Bright Stars for which these data have been lacking. (auth)

2680 uvbyβ PHOTOMETRY OF STARS IN THE DIRECTION OF THE ASSOCIATION PERSEUS OB2. Rydgren, A. E. (Manned Spacecraft Center, Houston, Tex. Univ. of Arizona, Tucson). Publ. Astron. Soc. Pac.; 83: No. 495, 656-62(Oct 1971).

The interstellar absorption in the direction of the association Perseus OB 2 was studied by uvbyβ photometry of 35 early-type stars in four fields. Most of the obscuration seemed to be concentrated between 100 and 200 parsecs from the Sun, rather than between 200 and 300 parsecs as previously suggested by Lynds (1969). (auth)

2681 EVOLUTION IN CLOSE BINARY SYSTEMS. Kopal, Zdenek (Univ. of Manchester, Eng.p). Publ. Astron. Soc. Pac.; 83: No. 495, 521-38(Oct 1971).

A comparison of the consequences of current theories of stellar evolution with known observational aspects of close binary systems leads to nine conclusions which are listed. (auth)

2682 SURFACE CHARACTERISTICS OF THE MAGNETIC STARS. Preston, George W. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac.; 83: No. 495, 571-84(Oct 1971).

The magnetic stars (A_p) lie on or near the main sequence with effective temperatures in the range $8000 \lesssim T_e \lesssim 15{,}000°K$. The present review is confined primarily to developments since 1965. (W.D.M.)

2683 NUCLEAR PROCESSES ASSOCIATED WITH PECULIAR A-TYPE STARS. Cameron, A. G. W. (Yeshiva Univ., New York. Goddard Inst. for Space Studies, New York). Publ. Astron. Soc. Pac.; 83: No. 495, 585-91(Oct 1971).

Various roles that both internal and surface nuclear reactions may play in production of anomalous abundances of elements in peculiar A stars are discussed. (auth)

2684 THEORETICAL ASPECTS OF MAGNETIC STARS. Woltjer, L. (Columbia Univ., New York). Publ. Astron. Soc. Pac.; 83: No. 495, 592-3(Oct 1971).

Equations are given from which maximum rms fields of 10^8 gauss for typical main-sequence stars, 10^{12} gauss for white dwarfs, and 10^{17} gauss for neutron stars are obtained. Theoretical model problems for the magnetic stars are considered. (W.D.M.)

2685 NEW POINT γ-RAY SOURCE Lib γ-1; EVIDENCE OF TIME VARIATION AND POSSIBLE IDENTIFICATION WITH PKS 1514-24. Frye, G. M. (Case Western Reserve Univ., Cleveland). Nature (London); 233: No. 5320, 466-8(15 Oct 1971).

Evidence had been obtained for the existence of four point sources of high-energy γ radiation (>50 MeV). In the present communication a further point γ-ray source, termed Libra γ-1, is reported, detected on a balloon flight in Nov. 1971, and it is stated that direct experimental evidence for the time variation of a γ-ray source was obtained. The angular resolution circle in the direction of Lib γ-1 included PKS 1514-24, which is also an optical variable. No large variation in flux was observed over 6 hr for Lib γ-1, but there was a definite variation over 9 months, as shown by comparison with data from an earlier flight. This is discussed in the light of Shkovsky's theory (Astron. αZh., 47: 742(1970)), which postulates that the γ rays are generated by bremsstrahlung from the fast electrons that produce the varying radiation at lower frequencies by synchrotron radiation, and predicts that the surges of γ rays should last over several days or weeks, separated by intervals of the order of a year. (UK)

2686 GUM NEBULA: A NEW KIND OF ASTRONOMICAL OBJECT. Maran, Stephen P. (Goddard Space Flight Center, Greenbelt, Md.); Brandt, John C.; Stecher, Theodore P. Phys. Today; 24: No. 9, 42-7(Sep 1971).

A model is proposed for the Gum Nebula in which the gases were ionized by ultraviolet radiation from the same supernova explosion that produced the Vela X remnant and the pulsar PSR 0833-45 that lies within the remnant. Because, in the model, the Gum Nebula was ionized by a star that no longer exists, it is called a "fossil Strömgren sphere." (W.D.M.)

2687 UPPER CENTAURUS ASSOCIATION. Glaspey, John Warren. Tucson, Ariz.; Univ. of Arizona (1971). 203p. University Microfilms Order No. 71-21,990.

Thesis.

The Scorpio–Centaurus association is one of the nearest groups of young B-type stars to show common streaming motions, and as such has played an important role in the determination of absolute magnitudes of B-type stars. Subgroups have been recognized within the Association; however, very little information was available concerning the Upper Centaurus–Lupus section (the Upper Centaurus association). To supplement the published data on the brighter B-type stars, photoelectric uvby and Hβ photometric data were obtained for a large number of faint B-, A-, and F-type stars in the Upper Scorpius and Upper Centaurus regions. With this information the published absolute magnitudes of the bright B-type star members as determined by a moving cluster analysis were used to check the accuracy of a preliminary calibration of M_v in terms of the β-index provided by Crawford of Kitt Peak. For the Upper Scorpius and the Upper Centaurus subgroups, the two types of absolute magnitudes show satisfactory agreement. For the Lower Centaurus–Crux B-type stars, however, the moving cluster absolute magnitudes are brighter than the Hβ absolute magnitudes by an average of 0.4 m. No explanation is given for this difference, if it is significant. Ages of B-type stars in the subgroups were estimated using theoretical evolutionary calculations. Isochrones were transformed into a β, $(u-b)_0$ diagram for direct comparison with the observed stellar sequences. For the Upper Centaurus association, age estimates ranged from 12 million to 16 million years, depending on the assumed chemical composition. A less-certain estimate of 10 million years was obtained for the Upper Scorpius association. (TSS) (Diss. Abstr. Int., B)

2688 STELLAR MASS LOSS INDUCED BY RADIATION PRESSURE AND ITS RELEVANCE TO PLANETARY NEBULAE. Schuerman, Donald W. Rochester, N. Y.; Univ. of Rochester (1971). 101p. University Microfilms Order No. 71-22,319.

Thesis.

It has long been known that since the gravitational attraction and the opposing radiation pressure force both decrease as r^{-2} in the outer portions of a sufficiently hot star, there exists a critical value of the luminosity above which outward mass motion must occur. In terms of the opacity, κ, and the interior mass M, the critical luminosity is given by $L_c \equiv 4\pi cGM/\kappa$. It is shown that steady-state hydrodynamic flows are possible even for $\delta \equiv L/L_c < 1$, and that this mechanism may be responsible for the mass-loss observed in planetary nebulae. Electron scattering is used for the opacity, and the Eddington approximation is assumed. For a mean molecular weight of $\frac{2}{3}$, a sufficient condition for the validity of the calculations is that $\delta \geq -0.14 \log(4\pi\lambda) + 0.16$ and $-0.2 > \log(4\pi\lambda) > -5.5$ where $4\pi\lambda$ is the mass flux in units of $M_\odot\ yr^{-1}$. The flows are subsonic near the base of the envelope, and in this region the total energy per gram of the gas is negative. At radii of 10^{12} to 10^{14} cm, the flows become supersonic. Here, the radiation field has transferred sufficient energy to the gas so that the energy per gram is positive, and the gas is still optically thick. It is also shown that the flow is stable against small radial perturbations and that convection is a negligible source of energy transfer. The observable quantities—defined at that radius where the optical depth is unity—are a function of the outer boundary condition employed. Two boundary conditions are used to investigate this effect. It is first assumed that the temperature vanishes at infinity. Models are also calculated using the condition that total energy per gram of the gas vanishes at zero temperature. The latter condition produces "effective temperatures" which in cases with larger mass fluxes are as much as a factor of 8 higher than those produced by the former boundary condition. However, the subsonic region and the criterion for mass loss are unaffected by the structure of the flow in the supersonic region. The values of mass flux ($-2.07 > \log(4\pi\lambda) > -5.5$), luminosity ($0.4 < \delta < 1.0$), velocity ($10^6$–$10^7$ cm sec^{-1}), temperature ($10^{4\circ}$K), and radius (10^{12}–10^{14} cm) are all compatible with those values expected for the precursors of planetary nebulae. (Diss. Abstr. Int., B)

2689 SPECTRA AND ELEMENT ABUNDANCES OF COOL WHITE DWARFS. Wegner, Gary Alan. Seattle, Wash.; Univ. of Washington (1971). 148p. University Microfilms Order No. 71-24,093.

Thesis.

Element abundances in the cool white dwarfs R627, R640, L745-46A, vMa2, and W489 were studied from new spectral observations with the 84-inch telescope at Kitt Peak National Observatory. No new metal lines were detected in the spectrum of R627. No lines at all were found in W489 and it should probably be classed as DC. In L745-46A, only Ca II H and K lines were seen, while in R640 and vMa2, Fe I, Mg I, and Ca II lines were observed. Model atmospheres were derived for these stars. The influence of convection was taken into account. A temperature correction procedure was devised to compute models which were flux constant in the radiative zone and had convective zones that were consistent with the mixing-length theory and the variable radiative flux below the point of the onset of convection. From the derived models, line profiles were computed. The individual element abundances could not be determined uniquely with the present information. Abundance differences seemed to exist from star to star. The most important examples were the relative abundances of Fe and Mg in R640 and vMa2 where $E_{Fe}/E_{Mg} = 1/30$ and $1/4$ respectively. (TSS) (Diss. Abstr. Int., B)

2690 TRANSPORT PROPERTIES OF NEUTRON STAR MATTER. Gentile, Antonio M. New York; Yeshiva Univ. (1971). 148p. University Microfilms Order No. 71-23,926.

Thesis.

Coefficients of transport in the deep interior of a neutron star were calculated from a relativistic Boltzmann equation. The effects of the degeneracy of the fermions present, and of the various binary collisions between the charged particles (e,μ,p) and with the other constituents (n,γ) were included. The motion of the heavy particle in a collision was considered also. The collective action for the collision between charged particles was considered, introducing a shielded Coulomb interaction. An iterative method of solution was devised that, in its initial step, reduces to Lee's calculations for the thermal conductivity. Then, with a variational method, expressions for the electric and thermal conductivity were obtained. The electric conductivity was only slightly higher (30%) than that obtained in the nonrelativistic calculation by Baym, Pethick, and Pines. A brief discussion of the viscosity and of the effect on the conductivity of the presence of superfluidity and superconductivity in neutron-star matter is given. Baym, Pethick, and Pines had estimated a decay time of 10^{13} years, by ohmic dissipation, for an established magnetic field in a neutron star. The more precise relativistic calculation given in the present work does not change that order of magnitude. (Diss. Abstr. Int., B)

2691 CARBON MONOXIDE ABSORPTION IN K AND M GIANTS AND THE $^{12}C/^{13}C$ ABUNDANCE RATIO. Bailey, Wayne Lewis. Tucson, Ariz.; Univ. of Arizona (1971). 141p. University Microfilms Order No. 71-24,887.

Thesis.

The second overtone vibration–rotation bands of carbon mon-

oxide were used to determine the $^{12}C/^{13}C$ abundance ratio in fifteen stars of spectral types K2 through M6, luminosity classes III through Ia. The relation of the results to theoretical studies of the structure of evolved stars is discussed. Twenty three spectra of the fifteen stars, covering the wave-number region 3900 to 8200 cm^{-1} or 2400 to 8200 cm^{-1} with a resolution of 8 cm^{-1} were analyzed. A grid of synthetic carbon monoxide spectra was calculated using a Milne–Eddington curve of growth, for various values of $^{12}C/^{13}C$ ratio, temperature, microturbulent velocity, and damping parameter. These synthetic spectra were used to construct curves of growth for the band heads which were used to determine the $^{12}C/^{13}C$ ratio from the stellar spectra. The $^{12}C/^{13}C$ ratio was significantly lower than the terrestrial value in all stars studied. This was interpreted as an indication that material, which has been processed through the CNO bi-cycle, has been transported from the interiors to the surfaces of the stars. This agrees with the theoretical models of the interiors of red giants which predict a convective zone extending from the surface of the CNO burning shell. The ratio of carbon monoxide line to continuum opacity was determined. No attempt was made to interpret this ratio as a CO/H abundance ratio due to uncertainties in the continuous opacity. (Diss. Abstr. Int., B)

2692 SOME INTRINSIC PROPERTIES OF CARBON STARS. Richer, Harvey Brian. Rochester, N. Y.; Univ. of Rochester (1971). 108p. University Microfilms Order No. 71-22,315.

Thesis.

Some intrinsic properties of carbon stars were investigated using spectroscopic and photoelectric data. By employing spectrograms of moderate dispersion (124 Å/mm) in the infrared region (λλ7000 to 8800), a new two-dimensional classification scheme involving temperature and luminosity was established for carbon stars. The temperature subtypes are shown to be consistent with the (I–L) effective temperature calibration of Johnson. Intrinsic colors of the spectral subtypes were determined and these were used to construct a color–color diagram which clearly separated out the early and late-type carbon stars. A galactic rotation solution, using radial velocities and intrinsic colors, yielded a mean absolute magnitude of –2.7 for the middle carbon stars. This value was employed to construct the M_{bol}–log T_e diagram for carbon stars. They were found to form an extension of the giant branch to cooler temperature. Radial velocities were determined for 78 carbon stars using the infrared spectra. Intercomparison of these with velocities obtained at much higher dispersion showed no systematic error between the two. (Diss. Abstr. Int., B)

2693 SPACE DISTRIBUTION OF STARS IN THE SOUTHERN MILKY WAY: A REGION IN VELA. Wooden II, William Hugh. Cleveland; Case Western Reserve Univ. (1971). 190p. University Microfilms Order No. 71-22,868.

Thesis.

V magnitudes, B – V colors, and spectral types were determined for 6195 stars in the region LF 13, an area of 17.1 square degrees centered at $l^{II} = 281°$, $b^{II} = +3°.9$. A catalogue of the data is given. The magnitude limit of the data is approximately V = 12.5. The interstellar absorption in the region is $A_v = 0.7$ magnitude at 1 kiloparsec and $A_v = 1.2$ magnitudes at 5 kiloparsecs. It appears that the region is a local window in the Galaxy. Space densities of the stars in LF 13 were computed as a function of spectral type and distance from the Sun. The B0–B3 stars more distant than 4 kiloparsecs tend to lie at longitudes greater than 281°. Concentrations of early A, A2–A6, and gG7–K4 stars were found at 600 parsecs from the Sun. The space density of the A7–F5 stars is twice the average value found for other galactic regions at 600 parsecs. General luminosity functions, log ϕ (M_v), evaluated at 100, 200, 400, and 600 parsecs do not differ substantially from the standard van Rhijn function. (Diss. Abstr. Int., B)

2694 STAR SPOTS OR GREY VEILS: CC ERI AND OTHERS. Evans, David S. (Univ. of Texas, Austin). Mon. Notic. Roy. Astron. Soc.; 154: No. 3, 329-38(1971).

A discussion of the photometric phenomena exhibited by CC Eri in the light of a theory of star spots produces an explanation in which the "spots" are not on the surface but are neutral absorbing clouds at two of the collinear Lagrangian points. The theory of spots on the star surface accounts for the light curves of the stars described by Krzeminski (1969) but some unexplained differences between these stars and CC Eri remain. (auth) (UK)

2695 MERIDIONAL CIRCULATION IN ROTATING STELLAR ATMOSPHERES. II. THE EFFECT OF VARIABLE OPACITY. Brand, D.; Smith, R. Connon (Univ. of Sussex, Brighton, Eng.). Mon. Notic. Roy. Astron. Soc.; 154: No. 3, 293-300(1971).

In a previous paper (Smith, Mon. Notic. Roy. Astron. Soc., 148: 275(1970)) the circulation currents in a uniformly rotating stellar atmosphere with constant opacity were discussed. The present paper investigates the effect of removing the restriction of constant opacity. It is found that the circulation pattern is qualitatively the same as for constant opacity. (auth) (UK)

2696 HIGH-SPEED PHOTOMETRY. Kibblewhite, E. J.; Willstrop, R. V. (Cambridge Observatories, Eng.). Mon. Notic. Roy. Astron. Soc.; 154: No. 3, 301-19(1971).

Equipment for recording the light of rapidly variable objects, and the methods of analysis of the data are described. The equipment was used in searches for regular fluctuations in the light received from the directions of pulsars and supernovae remnants and in the light of white dwarf stars, a flare star, the nuclei of normal and Seyfert galaxies, some radio sources, the remnant of Nova (DQ) Herculis 1934, and the central star of M57. The known variability of DQ Her and NP 0532 was confirmed, and upper limits were placed on any other variations. (auth) (UK)

2697 THEORETICAL COLOURS FOR F AND G DWARF STARS. Bell, R. A. (Univ. of Maryland, College Park). Mon. Notic. Roy. Astron. Soc.; 154: No. 3, 343-83(1971).

Synthetic spectra were computed for F and G dwarf stars, using a number of values of chemical abundance, Doppler broadening velocity, and damping constant. Filter transmission functions were convolved with these spectra to yield the U – B, B – V, R – I, m_1, c_1, b – y, β, 33 – 52, 35 – 52, 37 – 52, 40 – 52, 45 – 52, 52 – 58, and 52 – 63 colors of the models. The metal abundances of a number of stars were obtained using computed and observed m_1 and 40 – 52 colors. These abundances are in good agreement with spectroscopically determined ones. The c_1 colors of stars with accurately known trigonometric parallaxes were used in order to determine how accurately absolute magnitudes can be predicted from the colors. Generally reasonable agreement can be obtained between observed and predicted absolute magnitudes for stars which have b – y ≤ 0.38, the b – y color having been corrected to [Fe/H] = 0. It is found that the predicted variation of ultraviolet excess, δ(U – B), is only half that which is observed. Predicted and observed values of δ(U – B) would be in better agreement if higher gravities were assigned to metal deficient models than to normal abundance models. The decrease in line blocking caused by a decrease in metal abundance is counterbalanced to some extent by the fact that the damping constant is larger for metal deficient models than for normal abundance models. The effects of interstellar reddening on the colors of the models were examined. (UK)

2698 NATURE OF CENTAURUS X-2. Sofia, Sabatino (Univ. of South Florida, Tampa). Mon. Notic. Roy. Astron. Soc.; 154: No. 3, 9P-13P(1971).

New astrometric evidence is presented which indicates that the variable star WX Cen, which has been proposed as the optical object associated with the x-ray source Cen X-2, is probably not a member of the Scorpio–Centaurus association. Instead, it may belong to one of two possible groups of stars at a distance of approximately 200 to 2000 pc, respectively. If the object is located at the greater distance, it lies essentially on the main sequence. If, on the other hand, it is at 200 pc, it is a highly underluminous, compact object, similar to Sco X-1. In view of the rather inaccurate photometric and spectroscopic data presently available, however, this result is only tentative, and should be verified by observing stars indicated. (auth) (UK)

2699 VARIABILITY OF RADIATION FROM CIRCUMSTELLAR GRAINS SURROUNDING R CORONAE BOREALIS. Forrest, W. J. (Univ. of California, San Diego); Gillett, F. C.; Stein, W. A. Astrophys. J.; 170: No. 1, L29-31(15 Nov 1971).

Radiation at infrared wavelengths from circumstellar grains surrounding R CrB has been observed for approximately 3 years. Variations of flux with time have been larger at λ = 3.5 μ than at λ = 11 μ. The change in the shape of the spectrum is discussed. (auth)

2700 NATURE OF BECKLIN'S STAR. Penston, M. V. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Allen, D. A.; Hyland, A. R. Astrophys. J.; 170: No. 1, L33-7(15 Nov 1971).

It is suggested that Becklin's star is an extremely reddened star. (auth)

2701 G61-29: A HELIUM EMISSION-LINE STAR. Burbidge, E. M.; Strittmatter, P. A. (Univ. of California, San Diego). Astrophys. J.; 170: No. 1, L39-42(15 Nov 1971).

Spectrograms of G61–29 reveal that it is a helium emission-line star, probably a white dwarf. The spectrum is described, and possible interpretations are briefly discussed. (auth)

2702 PREDICTION OF THE RATE OF THE $^{12}C(\alpha,\gamma)^{16}O$ REACTION IN HELIUM BURNING. Arnett, W. David (Inst. of Theoretical Astronomy, Cambridge, Eng. Univ. of Texas, Austin). Astrophys. J.; 170: No. 1, L43-5(15 Nov 1971).

A relatively simple use of current astrophysical theory relates the observed abundance ratio $^{12}C/^{16}O$ to the rate of the reaction $^{12}C(\alpha,\gamma)^{16}O$ during core helium burning in massive stars. This quantitative prediction may soon be compared with experimental measurements of $^{12}C(\alpha,\gamma)^{16}O$ at low energy which are now under way. (auth)

2703 REDUCED WIDTH OF THE 7.115-MeV LEVEL IN ^{16}O. Vidal, N. V.; Shaviv, G.; Kozlovsky, B. Z. (Tel-Aviv Univ., Ramat-Aviv, Israel). Astrophys. Lett.; 9: No. 3, 131-3(Oct 1971).

Recent measurements of two parameters in the triple-α and the subsequent reaction warrant a new calculation of the abundance curve. An astrophysical low limit for the reduced width of the 7.115-MeV level in ^{16}O permits a fair narrowing of its range. (auth)

2704 DECAY OF RADIATIVE MAGNETOHYDRODYNAMIC SHOCK WAVES IN THE ATMOSPHERE OF B STARS. Bhatnagar, M. S. (Univ. of Delhi); Kulshrestha, K. P.; Tandon, J. N. Astrophys. Lett.; 9: No. 3, 135-7(Oct 1971).

Differential equations describing the decay of a hydromagnetic shock through a stellar atmosphere are derived. It is shown that an isothermal shock decays more rapidly than a nonmagnetic shock. Comparison of the theoretical velocity curve with the radial-velocity observations of BW-Vulpeculae, a β-Cephei, star is made. (auth)

2705 OPTICAL IDENTIFICATION OF INFRARED SOURCES. Cohen, Martin (Observatories, Cambridge, Eng.). Astrophys. Lett.; 9: No. 3, 95-100(Oct 1971).

Optical identifications are presented for eight infrared sources from the Two Micron Sky Survey which have unusual photographic appearance or location. One source may belong to an open cluster, a second lies in an obscured region of an emission nebula, and a third may be associated with a globular cluster. (auth)

2706 LUMINOSITY FUNCTION OF OLD-DISK RED GIANTS COMPARED WITH THEORETICAL RATES OF EVOLUTION. Tinsley, Beatrice M. (Univ. of Texas, Dallas). Astrophys. Lett.; 9: No. 3, 105-8(Oct 1971).

A rich sample of low-mass old-disk giants was obtained from six very similar groups discovered by Eggen. Their combined luminosity function was compared with Iben's theoretical track for a Population I star of 1.25 $M_\odot$, which ends at $M_{bol} = -3.2$, at core helium ignition. It was found, after allowance for selection effects and statistical uncertainty (~25%), that the distribution of subgiants and giants up to $M_{bol} = -3.2$ is compatible with evolution at the theoretical rate, except that about half the giants in the "clump" at $+1 > M_{bol} > 0$ must be in a later stage lasting ~50 million years. The 23 known group members brighter than the theoretical track must be in later stages totaling 5 million years. It appears that about 70% of the nuclear energy available to the star is consumed by the end of the main-sequence and red-giant stages of evolution. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 2761.

2707 PROGRESS IN X-RAY ASTRONOMY. Shklovskii, I. S. Vestn. Akad. Nauk SSSR; No. 8, 81-4(Aug 1971). (In Russian).

This brief review is concerned with recent progress made in the field of x-ray astronomy. The first cosmic source of x radiation was discovered in 1963; shortly afterwards, the Crab Nebula radiation was studied. Approximately 60 sources of x radiation are known to astronomers, most of these sources being concentrated in the Milky Way. Certain spectral lines, stellar masses, plasmas, and quasars are briefly discussed in this connection. (K.S.W.)

2708 EXTRA-ATMOSPHERIC RADIO-ASTRONOMICAL INVESTIGATIONS. Getmantsev, G. G.; Salomonovich, A. E.; Spysh, V. I. Vestn. Akad. Nauk SSSR; No. 4, 55-60(Apr 1969). (In Russian).

Certain components of the Earth's atmosphere absorb and scatter certain wavelengths, rendering terrestrial radio astronomy difficult. Extra-atmospheric studies below 10 MHz (<30 m) have been made possible by artificial satellites and rockets that rise above the F layer of the ionosphere. A maximum intensity of cosmic radiation apparently lies at about 3 MHz on the rf spectrum. The electron temperature in the outer corona of the Sun is analyzed. Plasma resonances and the so-called "plasma waves" may be detected in radio signals. Submillimeter wavelength studies are possible only above the atmosphere of the Earth. Infrared stars, quasi-stellar sources of radio emission, and other recent work at various observatories are summarized. (K.S.W.)

2709 DECAMETER RADIO ASTRONOMY. Braude, S. Ya. Vestn. Akad. Nauk SSSR; No. 4, 32-8(Apr 1969). (In Russian).

Radioastronomical measurements are rendered difficult in the lower MHz range because of interference with radio station signals, but nevertheless are important because of the association with cosmic plasma and relativistic particles moving in magnetic fields. Four different types of rf spectra have been detected and classified, all in the frequency range 10 to 1,000 MHz. The corresponding frequencies of occurrence of the four types are I—55%, II—6%, III—35%, and IV—4%. The various cosmic sources responsible for the four rf spectra are discussed. (K.S.W.)

2710 EXCITED HYDROGEN RADIO LINES. Sorochenko, R. L. Vestn. Akad. Nauk SSSR; No. 4, 39-45(Apr 1969). (In Russian).

Interaction of excited atoms with electrons and ions can lead to Stark broadening, diffusion, and loss of contrast on the background of continuous spectra. Wavelength should increase, since higher atomic levels are involved, but this type of excitation is not observed on the Earth due to the degree of rarefaction required. The spectral lines of hydrogen in the optical and rf ranges are compared, and their importance in astrophysics is stressed. An original spectrogram of the radio lines of hydrogen from 91 to 90 MHz is presented and discussed. Broadening of the radio lines of excited hydrogen in the Omega nebula and other cosmic sources was studied as a function of the wavelength. (K.S.W.)

2711 ELECTROMAGNETIC PULSAR MODELS. Gunn, James E. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac.; 83: No. 495, 594-8(Oct 1971).

The general features and predictions of a group of pulsar models that may be classed as electromagnetic models are briefly reviewed. They are characterized by the suppositions that pulsars are rotating neutron stars with strong dipolar magnetic fields, and that it is the stress carried by these fields that is responsible for the slowing down of the rotation, the energy output, and, directly or indirectly, the other observable features. (W.D.M.)

2712 CHARGED PARTICLE MOTION NEAR PULSARS. Goldreich, Peter (California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac.; 83: No. 495, 599-601(Oct 1971).

Some general features of charged-particle motion in strong electromagnetic fields are described. Much of the discussion is in the nature of a selective review of current thoughts on pulsars. Those areas in which some agreement has been reached are considered, and remaining difficulties are pointed out. Some recent work on coherent synchrotron radiation is mentioned. (W.D.M.)

2713 CATALOGUE OF QUASARS. De Veny, James B. (Kitt Peak National Observatory, Tucson, Ariz.); Osborn, Wayne H.; Janes, Kenneth. Publ. Astron. Soc. Pac.; 83: No. 495, 611-25(Oct 1971).

Important optical data were catalogued and a bibliography was collected for all quasars with redshifts published prior to May or June 1971, including objects with only one spectral line. References to optical identifications, alternate designations, photometry, redshifts, proper motions, variability, spectrophotometry, and polarization measurements are given. (auth)

2714 SOFT X-RAY EMISSION FROM GALACTIC RADIO SPURS. Ilovaisky, S. A.; Bowyer, S. (Univ. of California, Berkeley). Nature (London); 233: No. 5320, 469-71(15 Oct 1971).

The interesting possibility that the galactic radio spurs could be soft x-ray sources is discussed, and the proposed association between radio spurs and soft-x-ray emission is questioned, with particular reference to identification of soft x-ray emission with the North Polar Spur (see Bowyer, Nature 217: 32(1968)), and also with reference to the Cetus Arc in the southern galactic hemisphere. The association between radio spurs and supernova remnants is also discussed. It is concluded that the soft x-ray enhancement detected by Bowyer near the North Polar Spur is best interpreted as the result of atmospheric scattering of solar x rays, and that both on theoretical and observational grounds

galactic spurs are not, in general, sources of soft x-ray emission. The Cetus Arc may well be a supernova remnant; if it is, however, it has long since ceased to be a source of x-ray emission. (UK)

2715 SHORT-TERM VARIABILITY OF PULSATIONS IN THE X-RAY FLUX FROM CYGNUS XI. Cruise, A. M.; Newton, A. C.; Chapman, C. E. (University Coll., London). Nature (London); 233: No. 5320, 468-9(15 Oct 1971).

Some data are reported from a sounding rocket flight from Woomera, South Australia, on Nov. 11, 1970 in which the x-ray source Cyg^{X-1} was examined, using a collimated proportional counter sensitive to x rays in the range 2 to 14 keV. Each x-ray event was indicated through the telemetry link by a 300-μs analogue pulse whose height was proportional to the incoming photon energy. The light curve was searched for the presence of significant variations in the x-ray flux. The only period detected was at 230 ms. (UK)

2716 NEUTRON STARQUAKES AND PULSAR SPEEDUP. Baym, Gordon; Pines, David (NORDITA, Copenhagen. Univ. of Illinois, Urbana). Ann. Phys. (N. Y.); 66: No. 2, 816-35 (Aug 1971).

A simple model of pulsar speedup due to starquakes is given that enables one to predict the time to the next starquake from the magnitude of the prior one. The parameters of the theory are estimated for recent models of neutron stars. The starquake explanation of speedup leads one to conclude that the Crab pulsar is a fairly light neutron star and the pulsar in Vela lighter still. The energy release in starquakes is discussed, and it is estimated that the Crab pulsar released at best 7×10^{40} ergs in its quake of September, 1969. The geometry of starquakes is considered for the simple model of a self-gravitating elastic incompressible sphere. A brief discussion of plastic flow in neutron star crusts is given. (auth)

2717 OPTICAL VARIATIONS OF QUASARS AND RELATED GALAXIES. Folsom III, George H. Gainesville, Fla.; Univ. of Florida (1970) 238p. University Microfilms Order No. 71-24,422.

Thesis.

Since late 1968 a program of photographic photometry of variable radio sources has been under way with the 30-inch reflector of the Rosemary Hill Observatory. A main purpose of this program is to find new variables from among optically identified radio sources, and to study the kinds of variability exhibited by these objects. Other objectives are to monitor a few known optical variables as a contribution to the field, and to use the variability criterion as a guide to optical identifications for unidentified sources. (TSS) (Diss. Abstr. Int., B)

2718 CRAB NEBULA AND ITS PULSAR. Murdin, Paul Geoffrey. Rochester, N. Y.; Univ. of Rochester (1970). 180p. University Microfilms Order No. 71-22,311.

Thesis.

The Crab Nebula as an astrophysical object is described, and evidence that it contains an active, energetic supernova remnant identified with the pulsar NP 0532 is detailed. Apparatus to detect flashes of the pulsar and relate the epoch of the flashes to a recognized clock system (the A. 1. time frame) at the 10-μsec level of accuracy is described. The reduction procedures necessary to transform the observed times to a physically relevant space–time frame, namely, the inertial frame attached to the barycenter of the solar system, are critically dependent on a knowledge of the position of the Earth and other solar system parameters such as the masses of the outer planets. Relativistic time-dilation phenomena on terrestrial clocks are an essential part of the reduction procedure. The apparatus and procedures described were used to follow the behavior of the pulsar during the 1969–1970 observing season. There were differences with previous results. There were no quasi-sinusoidal oscillations at the level previously reported and there was a small, but probably significant, increase in the rate of change of the period of the pulsar by 2 parts in 10^5. These changes may have been caused by the spinup event of September 28, 1969 which occurred immediately before these observations. Perhaps the oscillations represent a growing instability culminating in the spinup. The starquake theory of the spinup observed in the Vela pulsar is described and modifications that would account for the behavior that followed the spinup of the Crab Nebula pulsar are proposed. The modifications are dependent on the theory accepted for the rate of loss of rotational energy. The one which is most consistent with the observed value of the braking index of 2.22 views the pulsar as a rotating neutron star, losing angular momentum by a mixture of mass loss and magnetic dipole mechanisms, the magnetic field of the star being threaded through the crust of the neutron star. The spinup or starquake in September 1969 is supposed due to a relaxation of the crust, which compressed the magnetic field and caused greater radiation loss. There is the possibility that gravitational radiation plays a part in the loss of the rotational energy and in that case it seems that the starquake may have caused an increase in the asphericity of the neutron star. (Diss. Abstr. Int., B)

2719 INVESTIGATION INTO THE OPTICAL FLUORESCENCE OF INTERSTELLAR H I. Reynolds, Ronald Jay. Madison, Wis.; Univ. of Wisconsin (1971). 139p. University Microfilms Order No. 71-16,896.

Thesis.

There have been various interstellar ionization and heating mechanisms proposed to explain the seemingly high interstellar electron densities indicated by pulsar dispersion measures. Whatever the mechanism, the ionization of the interstellar hydrogen will result in hydrogen recombination line emission. A search for the resulting Hβ emission was conducted using a 2-inch diameter Fabry–Perot spectrometer at the coudé focus of the 36-inch telescope at Goddard Space Flight Center, Greenbelt, Maryland. Observations were made near the directions of four pulsars (PSR 0532, PSR 1508, PSR 1541, and PSR 1642) between November 1969 and June 1970. Emissions with fluxes from 4 to 40×10^4 photons/cm^2 sec ster were detected in three of the directions. Although the sources of these emissions could not be uniquely determined, the data indicate both an average ionization rate (assuming steady state) of $\simeq 10^{-14}$/H/atom sec for the interstellar hydrogen and, depending upon the particular direction, temperature between 10^3°K and 10^4°K for the emitting regions. (Diss. Abstr. Int., B)

2720 LINEAR POLARIZATION MEASUREMENTS OF PSR 0833-45 AND THEIR RELEVANCE TO PULSAR MODELS. Komesaroff, M. M. (CSIRO, Sydney); Ables, J. G.; Hamilton, P. A. Astrophys. Lett.; 9: No. 3, 101-4(Oct 1971).

Measurements between 300 and 1420 MHz show that for PSR 0833-45 the pulse shape, as well as the degree and position angle of the linear polarization, are frequency-invariant when allowance has been made for interstellar scattering and Faraday rotation. The polarization is thus not measurably affected by propagation through the dense plasma and intense magnetic field believed to be associated with the pulsar magnetosphere. An explanation is suggested in terms of a pulsar model due to Sturrock, which involves relativistic streaming of charged particles along polar magnetic field lines. (auth)

2721 PROFILES OF RADIO RECOMBINATION LINES. Brocklehurst, M.; Seaton, M. J. (University Coll., London). Astrophys. Lett.; 9: No. 3, 139-42(Oct 1971).

Using the theory of impact broadening and the observed profiles of radio recombination lines, Brocklehurst and Leeman (1971) have shown that the high lines must be formed in regions of low density. In order to interpret all of the observed line profiles and intensities, it is necessary to consider models of variable density. A convenient approximate solution of the transfer equation was obtained and it is shown that, using plausible density distributions, one can obtain calculated results in agreement with observations. (auth)

2722 TRANSITION RADIATION AS A COSMIC X-RAY SOURCE. Johansson, Sven A. E. (Univ. of Lund, Sweden). Astrophys. Lett.; 9: No. 3, 143-6(Oct 1971).

Transition radiation is emitted when a charged particle traverses a boundary separating two media. Such radiation must therefore be emitted as x rays and ultraviolet radiation in interstellar space, supernova remnants, and some other objects where cosmic-ray electrons pass through dust grains. Calculations show that the transition radiation emitted in this way might account for the soft x rays emitted from various cosmic sources. The possibility of observing transition radiation emitted in the ultraviolet region is also discussed. (auth)

2723 X-RAY OBSERVATION OF NEW SOFT SOURCE IN CYGNUS. Coleman, P. L.; Bunner, A. N.; Kraushaar, W. L.; McCammon, D. (Univ. of Wisconsin, Madison). Astrophys. J.; 170: No. 1, L47-9(15 Nov 1971).

A new point x-ray source was detected in Cygnus whose incident flux is confined to the energy range 0.5 to 1.3 keV. Its spectrum is consistent with line emission at ~1 keV or thermal bremsstrahlung at ~$10^{6.6}$°K with significant interstellar absorption. (auth)

2724 NATURE OF THE GALACTIC RADIO SOURCE G45.5 + 0.1. Wynn-Williams, C. G. (Cavendish Lab., Cambridge, Eng.); Downes, D.; Wilson, T. L. Astrophys. Lett.; 9: No. 3, 113-116 (Oct 1971).

The galactic radio source G45.5 + 0.1, recently suggested to be a supernova remnant with a flat spectrum, was mapped in the con-

tinuum with the Cambridge One Mile Telescope at 2.7 and 5 GHz and resolved into three components with angular sizes of the order of 20 arc sec. A new search at NRAO for the H109α recombination line was successful and the source was found to have a normal ratio of line-to-continuum temperatures, in contradiction to previously published results. It was concluded that G45.5 + 0.1 is an H II region located in the Sagittarius spiral arm. (auth)

2725 LOW-FREQUENCY CUTOFF IN THE RADIO SPECTRUM OF SAGITTARIUS A. Brezgunov, V. N.; Dagkesamanskii, E. D.; Udal'tsov, V. A. (Lebedev Physical Inst., Moscow). Astrophys. Lett.; 9: No. 3, 117-19(Oct 1971).

The upper limits of flux densities of the radio source Sgr A were obtained at several frequencies in the range 100 to 120 MHz by observations with the east–west arm of the cross radio telescope of the Lebedev Physical Institute. It is pointed out that, in the case of the uniform model of a source, only the thermal absorption of radiation outside the source can explain the observational data, the optical depth of the absorbing layer τ being equal to 1 at 200 MHz. The observed spectrum can also be explained by assuming the presence of two components in the source, the nucleus and the halo, the nucleus contribution to the total emission of Sgr A dominating at frequencies higher than 5 GHz and abruptly falling at lower frequencies. (auth)

2726 FURTHER OBSERVATIONS OF PULSATING X-RAY SOURCE CYGNUS X-1 FROM UHURU. Schreier, E.; Gursky, H.; Kellogg, E.; Tananbaum, H.; Giacconi, R. (American Science and Engineering Inc., Cambridge, Mass.). Astrophys. J.; 170: No. 1, L21-7(15 Nov 1971).

Since the discovery of the pulsations from the x-ray source Cygnus X-1 more data from Uhuru have been analyzed. The conclusions reached about the temporal behavior of the source are: (1) Large fluctuations of intensity exist on all observed time scales ranging from 50 ms to 10 s containing up to 50% of the power. (2) Periodic pulse trains with periods from 0.3 s to over 10 s exist containing 10 to 25% of the power; however, they persist only for several seconds or several tens of seconds. (3) No single period is consistently present. This behavior is shown to reconcile the apparently contradictory results obtained by other observers. The energy spectrum of the source is best fitted by a power law, but with great variability in the spectral index and with an excess of flux at higher energies. (auth)

2727 HARD X-RAY SPECTRUM OF NP 0532. Cavani, C.; Frontera, F.; Fuligni, F.; Brini, D. (TESRE/CNR, Bologna). Nature (London) Phys. Sci.: 233: No. 43, 153-5(25 Oct 1971).

The final results are reported of the analysis of data obtained from a balloon flight from Gap (France) in June 1970, the object of the experiment being determination of the energy spectrum of the pulsed x-ray emission from NP 0532 in the energy range 20 to 200 keV (see Nature Phys. Sci., 232: 79(1971)). Pulse profiles for the four energy regions 20 to 40, 40 to 60, 60 to 100, and 100 to 200 keV are shown. It was found that the spectrum tended to become steeper in passing from lower to higher energies, where the pulsed emission appeared to have a spectral shape very similar to that of the steady radiation, and the shape of the pulsed spectrum was coincident, within experimental errors, with that of the total Crab emission. The pulsed spectrum, rather hard in the low-energy range, showed a break in shape at a few tens of keV, and at higher energies pulsed and steady spectra became similar. Results were compared with those of other authors, and showed good agreement. It is considered that the similarity of the spectral indices of the radiation emitted from the pulsar and the whole of the Crab Nebula at energy > 20 keV, is worth further consideration, and is discussed. (UK)

2728 RADIO SOURCES SIMILAR TO BL LAC. Nicholson, G. D. (National Inst. for Telecommunications Research, Johannesburg). Nature (London) Phys. Sci.; 233: No. 43, 155 (25 Oct 1971).

PKS 0727-11 and PKS 1514-24 were monitored at 2,295 MHz since 1967 as part of an extensive search for variable sources. Measurements were made with a 26-m telescope equipped with a maser radiometer at the NASA Deep Space Station 51, near Johannesburg. The observations were in the form of drift curves, analyzed digitally using least squares curve fitting techniques, and only the right circular component of the flux was measured. Only PKS 0727-11 was found to vary, and recent variations were so rapid as to require measurements at weekly intervals. It was concluded that PKS 0727-11 is an unusual variable, but whether it falls in the same class as BL Lac must await further measurements at higher frequencies. (UK)

2729 PULSAR MAGNETOSPHERE. Mestel, L. (Univ. of Manchester, Eng.). Nature (London) Phys. Sci.; 233: No. 43, 149-52(25 Oct 1971).

The arguments of Goldreich and Julian (Astrophys. J., 157: 869 (1969)) for a dense pulsar magnetosphere are extended to apply to the oblique rotator model. (auth) (UK)

Solar Phenomena

2730 (N-71-28024) LUNAR FOSSIL MAGNETISM AND PERTURBATIONS OF THE SOLAR WIND. Sonett, C. P.; Mihalov, J. D. (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). Jun 1971. 40p. (NASA-TM-X-62026). NTIS.

Perturbations of the solar wind downstream of the Moon and lying outside of the rarefaction wave that defines the diamagnetic cavity were used to define possible source regions comprised of intrinsically magnetized areas of the Moon. A map of the Moon was constructed, showing that a model where the sources are exposed to the grazing solar wind during the lunation yields a selenographically invariant set of regions strongly favoring the lunar highlands over the maria. An alternative model with the source due to electromagnetic induction was explored. The ages of the field sources should be consistent with those based upon the basalt ages, and possibly far older if the sources are connected with the formation of the highland rocks themselves. The perturbations were tentatively identified as weak shock waves, and a Mach angle in accord with nominal values for the solar wind was found. (auth) (STAR)

2731 (N-71-28080) EQUILIBRIUM ANISOTROPY IN THE FLUX OF 10-MeV SOLAR-FLARE PARTICLES AND THEIR CONVECTION IN THE SOLAR WIND. Forman, Miriam A. (Massachusetts Inst. of Tech., Cambridge. Center for Space Research). Sep 1969. Contract NAS2-3793. 25p. (NASA-CR-114299; CSR-P-69-26). NTIS.

The Compton–Getting (convective) part of the equilibrium anisotropy in the flux of 10-MeV solar-flare particles was calculated from particle spectra and solar-wind speeds for seven events observed by the spacecraft Pioneer 6 and 7 in 1966. The convective part accounted for most of the anisotropy in every case, and in four cases appeared to be the entire anisotropy. This shows that convection is important and must be included in a realistic theory of the propagation of low-energy solar cosmic rays, although it can be neglected at higher energies. Scattering by hydromagnetic waves may also be important. Furthermore, since the diffusive part of the anisotropy was radial when it was not zero, the diffusion of these particles appears to be, at least locally, isotropic. These conclusions depend on the facts that the convective part of the anisotropy is in the same direction as the solar wind, not perpendicular to the magnetic field, and that the correct formula for the Compton–Getting effect is $(2 + \alpha\gamma)$ V/v. (auth) (STAR)

2732 SOLAR-SYSTEM-FORMATION MODEL BASED ON SUPERNOVA SHELL FRAGMENTATION. Brown, Wilbur K. (Univ. of Wyoming, Laramie). Icarus; 15: No. 1, 120-34 (Aug 1971).

A new model of solar-system formation is presented that rests on the postulated breakup of an ejected supernova shell into massive fragments. Each fragment subsequently evolves into a separate and complete solar system. The model produces a powerful description of our solar system in both its overall regularity and its many anomalies. (auth)

2733 SLOWLY FLUCTUATING COMPONENT OF SOLAR RADIO EMISSION. Gel'freikh, G. B. Vestn. Akad. Nauk SSSR; No. 4, 46-54(Apr 1969). (In Russian).

A comparison of the resolving ability of the world's radio telescopes is made, showing that the range of resolution lies generally within the limits of 0.1 to about 6 min of arc and is sufficient for examination of the active areas of the Sun. The presence of local sources on the Sun was originally detected by slow changes in its total radio emission, and the "slowly changing component" is associated with an increase in the density of coronal material in the active areas of the Sun. Spectra in the 2- to 7-cm region of local sources are plotted on a graph showing fluctuations associated with sunspots. Brightness distribution around local sources at 5 cm is discussed, and a graph may reveal two distinct nuclei with diameter of about 20 sec of arc. The polarized structure characteristic of some sunspots is of importance. (K.S.W.)

2734 SOLAR WIND. Wolczek, Olgierd. Astronautyka; 13: No. 3, 2-8(1970). (In Polish).

The present state of knowledge about the solar wind and its effects in space and on planets is reviewed. The source, nature, and propagation of the solar wind are described; attention is given to the sectorial structure of the solar magnetic field, and the channeling of corpuscular radiation along force lines is discussed.

The interaction between the solar wind and the Earth's magnetosphere is outlined in terms of the MHD shock wave structure, the magnetopause, and the magnetosphere structure. (IAA)

2735 STABILITY OF SUNSPOT MAGNETIC FIELDS AND ORIGIN OF SOLAR FLARES. Sakurai, Kunitomo (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci.; 19: No. 10, 1289-96(Oct 1971).

The steady motion in sunspot magnetic regions is considered for both current-free and force-free configurations. The sufficient condition for stability is obtained in the presence of both external current-free and force-free magnetic fields and a steady motion. It is shown that the pattern of such steady motion is most important in triggering an instability of sunspot magnetic fields, both for the current-free and force-free configurations. When there is no steady motion, the current-free configuration of sunspot magnetic fields is always stable, whereas stability in the case of force-free magnetic fields is connected with the configuration. The onset of a solar flare seems to be associated with an instability associated with the steady motion within the sunspot magnetic regions. (auth) (UK)

2736 RADIO EMISSION AND SOLAR ACTIVITY. Maris, Georgeta (Astronomical Observatory, Bucharest). Stud. Cercet. Astron.; 16: No. 1, 81-102(1971). (In Rumanian).

In this survey, the following emission mechanisms are first considered: bremsstrahlung, synchrotron radiation, and Cherenkov radiation and plasma waves. Afterwards, solar radio bursts in the centimeter, decimeter, and meter ranges are discussed. 9 references. (L.M.T.)

2737 SOLAR MAGNETIC FIELDS: SMALL SCALE. Harvery J. (Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac.; 83: No. 495, 539-49(Oct 1971).

Observations related to the small-scale structure of solar magnetic fields are reviewed, with emphasis on recent photospheric measurements. (auth)

2738 SOLAR MAGNETIC FIELDS: LARGE SCALE. Howard, Robert (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac.; 83: No. 495, 550-60(Oct 1971).

The basic observations that bear on large-scale activity are discussed, and the Babcock model is described. Directions of research in the near future are considered. (W.D.M.)

2739 SOLAR MAGNETIC FIELDS: EXTENDED. Wilcox, John M. (Univ. of California, Berkeley). Publ. Astron. Soc. Pac.; 83: No. 495, 561-70(Oct 1971).

Spacecraft observations of the interplanetary magnetic field have revealed that almost always each solar rotation can be divided into sectors, within each of which the field has a predominant polarity toward the Sun or away from the Sun. Comparisons of this interplanetary magnetic-sector pattern with observations of the photospheric magnetic field have revealed a similar solar magnetic pattern. The boundaries between solar magnetic sectors are approximately in the north–south direction over a wide range of latitudes on both sides of the equator. This solar magnetic sector structure can be described as a rotating dipole whose magnetic axis makes an angle of approximately 90° with the axis of rotation. Possible similarities between this solar-sector magnetism and the models derived from observations of stellar magnetism are discussed. (auth)

2740 FORMATION OF THE SOLAR SYSTEM. Kumar, S. S. (Univ. of Virginia, Charlottesville). Nature (London); 233: No. 5320, 473-4(15 Oct 1971).

The significance of some properties of Jupiter for the problem of the origin of the solar system is discussed. The mass of Jupiter is 0.001 solar masses, and its orbital eccentricity is 0.05, and it is shown that these properties are primaeval and have not been affected by the evolution of the solar system. Consideration is given to what would happen to the planetary system if Jupiter's mass and/or the eccentricity of its orbit around the Sun changed. The discussion is extended to the problem of the existence of other planetary systems in the Galaxy, and it is concluded that the total number of planetary systems in the Galaxy is probably much smaller than estimated by some authors. (UK)

2741 ISOTOPIC COMPOSITION OF Mg AND THE IMPLIED LIMITS OF ^{26}Al IN THE EARLY SOLAR SYSTEM; NUCLEO-SYNTHESIS OF ^{26}Al; AND NUCLEOSYNTHETIC CHRONOLOGIES FOR THE GALAXY. Schramm, David Norman. Pasadena, Calif.; California Inst. of Tech. (1971). 160p. University Microfilms Order No. 71-21,901.

Thesis.

A particular isotope pair of astrophysical interest, ^{26}Al–^{26}Mg, was investigated in detail. A high-precision mass-spectrometric technique was developed whereby Mg isotopic compositions could be analyzed to better than five parts in 10^4. Feldspar (high Al, low Mg) mineral separates were carried out on several meteoritic and lunar samples. No anomalous ^{26}Mg values were found. Thus, there is no evidence for the existence of ^{26}Al at the formation of the solar system. Upper limits on the possible amount of ^{26}Al at solidification in the extraterrestrial samples were calculated. These limits were used to estimate the maximum change in central temperature of a planetary object that could be produced by the ^{26}Al decay. Production mechanisms for ^{26}Al are reviewed and it is shown that a flux of at least 4×10^{18} protons/cm^2 is required to produce enough ^{26}Al to melt the cores of planetary objects. The general problem of nucleosynthetic chronologies was investigated. Nucleochronologies for the galaxy were calculated using ^{235}U/^{238}U, ^{232}Th/^{238}U, ^{244}Pu/^{238}U (or preferably ^{244}Pu/^{232}Th), and ^{129}I/^{127}I. The systematics of the nucleochronologic equations were derived, and it was found that the mean age of the elements can be found from long-lived radioactive nuclei in a manner independent of the time-dependent production rate. It was also found that the interval between the termination of nucleosynthesis and the time of formation of solid bodies in the solar system can be determined model independently from the short-lived nuclei. In addition, some information on the time-dependent shape of the production function can also be determined model independently. (Diss. Abstr. Int., B)

2742 MOTION OF CHARGED PARTICLES IN A SPIRAL MAGNETIC FIELD AND TEMPERATURE ANISOTROPY. Khokhlov, M. Z. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 2, 222-7(Mar-Apr 1971).

Translated from Kosm. Issled.; 9: No. 2, 239-45(Mar-Apr 1971).

The motion of charged particles in a spiral magnetic field in a collisionless cycle applicable to solar-wind ions is discussed on the assumption that the rate of drift is small and the first adiabatic invariant is conserved. At low temperatures, approximate analytic solutions of the drift equations are similar to the solutions of the exact equations of motion of particles in a spiral magnetic field. On the basis of the analytic expression obtained for the distribution function, the temperature anisotropy curve is calculated. Together with a fall of the lateral temperature, a considerable fall of the longitudinal temperature occurs, which limits the increase of the temperature anisotropy. The maximum values of the anisotropy are reached in the model being considered, depending on the velocity of the solar wind at distances of 1 to 2 A.U. approximately. Estimates of the anisotropy magnitude coincide with the data from observations of temperature anisotropy of the solar-wind ions, with the assumption about the start of the process of establishing anisotropy with distance is approximately 0.3 to 0.5 A.U. A characteristic feature of the distribution function in comparison with an isotropic Maxwellian distribution (and also a bi-Maxwellian distribution) is its marked asymmetry with respect to the average velocity. (auth)

2743 MAGNESIUM HYDRIDE IN THE SUN. Lambert, D. L.; Mallia, E. A.; Petford, A. D. (Univ. of Texas, Austin). Mon. Notic. Roy. Astron. Soc.; 154: No. 3, 265-78(1971).

Low noise photoelectric scans of the MgH $A^2\Pi - X^2\Sigma(0,0)$ band in the spectrum of the solar disk were examined and accurate equivalent widths obtained. Analysis of these widths with a recent photospheric model atmosphere provides an estimate for the band oscillator strength: $f_{0,0} = 0.055$. A discussion of these weak MgH and strong Mg I lines in the disk spectrum and weak lines of MgH in the penumbral spectrum shows that limits can be set on the isotopic abundance ratios ^{25}Mg/^{24}Mg and ^{26}Mg/^{24}Mg. These limits are consistent with the terrestrial abundance ratios. Recent analyses of sunspot spectra which claim a marked overabundance of ^{25}Mg and ^{25}Mg relative to ^{24}Mg were critically examined. It is proposed that these results are in error owing to the neglect of a contribution to the spectrum from bright umbral dots. A new method of analysis is outlined. (auth)(UK)

2744 ERRORS IN NEUTRAL-IRON OSCILLATOR STRENGTHS. Bell, R. A.; Upson II, W. L. (Univ. of Maryland, College Park). Astrophys. Lett.; 9: No. 3, 109-12(Oct 1971).

It is suggested that the errors in the Fe I oscillator strengths of Corliss and co-workers are produced by errors in their photographic intensity scale. The suggestion that the errors are caused by errors in the adopted arc temperature is disproved by the solar curve of growth. (auth)

Galaxies

2745 EFFECT OF STAR–STAR COLLISIONS ON COOPERATIVE PHENOMENA IN ROTATING STELLAR SYSTEMS. Maro-

chnik, L. S.; Babkov, V. K. Byull. Inst. Astrofiz., Akad. Nauk Tadzh. SSR; No. 50, 16-19(1970). (In Russian).

The effect of star–star collisions on the rate of growth and damping of small perturbations is estimated. It is shown that star–star collisions increase the stability of stellar systems with respect to small density perturbations. An allowance for this effect is important when considering cooperative phenomena in systems where star–star collisions are significant. (IAA)

2746 INTRINSIC COLOR INDEX OF MAFFEI NO. 2. van den Bergh, Sidney (Univ. of Toronto). Publ. Astron. Soc. Pac.; 83: No. 495, 663(Oct 1971).

The maximum rotational velocities in late-type galaxies are strongly correlated with their integrated intrinsic color indices. This correlation was used to obtain an intrinsic color index $(B - V)_0 = 0.60 \pm 0.08$ m.e. for Maffei No. 2. (auth)

2747 OBSERVATIONAL CONSEQUENCES OF INVERSE COMPTON MODELS FOR SEYFERT GALAXIES. Bergeron, J.; Salpeter, E. E. (Cornell Univ., Ithaca, N. Y.). Astrophys. Lett.; 9: No. 3, 121-4(Oct 1971).

A simple model is reviewed for relativistic electrons in a compact region, where infrared emission is produced by synchrotron radiation and x-ray emission by the inverse Compton scattering of the infrared photons. The model parameters are given for the nuclei of three Seyfert galaxies and one quasar, which suggest rapid intensity variations (days or weeks). Production, by further Compton-scattering of the x rays, of a γ-ray flux is predicted, which should be observable at least for NGC 1275. (auth)

2748 IDENTIFICATION OF NUCLEUS OF NGC 5128. Kunkel, William E.; Bradt, Hale V. (Cerro Tololo Inter-American Observatory, La Serena, Chile). Astrophys. J.; 170: No. 1, L7-10(15 Nov 1971).

A "hot spot," 3″ by 5″ in size at the center of NGC 5128 (Cen A), was detected photographically at 8000 Å and identified with a relatively inconspicuous feature in blue photographs. From photometry in UBVRI, its luminosity was 2.4×10^{41} ergs s^{-1} if the distance is 5 Mpc and absorption by foreground dust is $A_v = 1.9$ magnitudes. This leads to a mass of 1.5×10^9 $M_\odot$ and density of 1.5×10^3 $M_\odot$ pc^{-3} for an assumed mass-to-light ratio of 40. The spot is located within 15″ of the centroid of the elliptical component and lies on the line connecting the centroids of the inner radio sources, and also on the axis of rotation proposed by Burbidge and Burbidge. The spectral energy distribution is not remarkable: there is no strong ultraviolet excess, nor are strong emission lines visible at 80 Å mm^{-1}. The Na I D-lines appear blended at a heliocentric radial velocity of + 475 km s^{-1}. (auth)

2749 RADIO EMISSION FROM NUCLEUS OF NGC 5128. Wade, C. M.; Hjellming, R. M.; Kellermann, K. I.; Wardle, J. F. C. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 170: No. 1, L11-13(15 Nov 1971).

A compact nonthermal radio source has been found within the infrared object suggested by Kunkel and Bradt as the nucleus of NGC 5128. The measured angular size is less than 0.5″, corresponding to linear dimensions of 13 pc or less. The increase in flux density toward shorter wavelengths indicates that the opacity is appreciable at centimeter wavelengths; this implies that the true angular diameter is of the order of 0.01″ or less. (auth)

2750 INFRARED OBSERVATIONS OF CORE OF CENTAURUS A, NGC 5128. Becklin, E. E. (California Inst. of Tech., Pasadena. Carnegie Institition of Washington, D. C.); Frogel, J. A.; Kleinmann, D. E.; (and others). Astrophys. J.; 170: No. 1, L15-19(15 Nov 1971).

Infrared radiation from the nucleus of NGC 5128 was measured from 1 to 10 μ. Scans and aperture-size data show that there is only one bright infrared region within the central 1′ of the galaxy and that it is coincident to within 5″ with the "hot spot" of Kunkel and Bradt. The 3.5- and 2.2-μ radiation is more peaked toward the center than are the shorter wavelengths. The data are interpreted to indicate a small nonstellar infrared core superposed on an extended, reddened stellar component. (auth)

Cosmology

Refer also to abstract 3416.

2751 (N-71-29924) COSMIC MATTER-ANTIMATTER ANNIHILATION AND THE GAMMA-RAY BACKGROUND SPECTRUM. Stecker, F. W.; Morgan, D. L. Jr.; Bredekamp, J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1971. 39p. (NASA-TM-X-65598; X-647-71-237). NTIS.

Initial results of a detailed calculation of the cosmological gamma-ray spectrum from matter–antimatter annihilation in the Universe are presented. The similarity of the calculated spectrum with the present observations of the gamma-ray background spectrum above 1 MeV suggests that such observations may be evidence of the existence of antimatter on a large scale in the Universe. Quantitative comparison of the calculations with the existing observations indicates the product of interacting matter and antimatter densities. (auth) (STAR)

2752 INVESTIGATIONS OF GEOMETRIC PROPERTIES OF SOME FOUR-DIMENSIONAL VARIETIES. Navez, J. (Univ., Liege). Mem. Soc. Roy. Sci. Liege; 1: No. 1, 7-58(1971). (In French).

The intrinsic geometric properties of a very large group of cosmological models were studied and these properties are presented as systematically as possible. The criteria for the classification of the Riemannian varieties are presented. The genre of the models considered is reported. The Christoffel symbols, the tensor components of Riemann and Ricci, and conformal curvature of these models are enumerated. A determination is made of those that are pseudo-Euclidian and those that are conformally flat. The geometric concept of the class of models considered is studied. All the motion groups and the Lie algebra associated with the spaces considered are determined systematically. (tr-auth)

2753 COSMIC GAMMA RAYS. Stecker, Floyd William. Baltimore; Mono Book Corporation (1971). 254p.

Most of the book is devoted to a detailed discussion of the high-energy processes, primarily in the realm of modern particle physics, which lead to the production of cosmic γ rays. The physics of these processes is then applied to the problems of astronomy and cosmic-ray physics that γ-ray astronomy is best suited to solve. The cosmological significance of the energy spectra of extragalactic γ rays is examined. An appendix contains a discussion of γ-ray telescopes and the latest techniques being developed for the detection of cosmic γ rays. (W.D.M.)

2754 CLOSED ROTATING COSMOLOGIES CONTAINING MATTER DESCRIBED BY THE KINETIC THEORY. A. FORMALISM. Matzner, Richard A. (Univ. of Texas, Austin. Wesleyan Univ., Middletown, Conn.). Ann. Phys. (N. Y.); 65: No. 1-2, 438-81(15 Jun 1971).

The kinetic theory of collisionless systems in closed, anisotropic (Bianchi Type IX) cosmologies, including the effects of rotation was investigated, and it is shown that for collisionless radiation produced in a thermal process (i.e. which had a thermal distribution at one instant), the energy density T_{00} can be written $\rho\nu[1 + Vv(\beta,t)]$, where $\rho\nu \propto R^{-4}$ and $Vv(\beta,t) \geq 0$ is a function of the anisotropy, β, and of the time. The exact form of V_ν cannot be given explicitly, but several limiting cases are given including the small anisotropy limit. The behavior of the distribution function for two special cases (subsets of the full rotating situation) is discussed. A Lagrangian is presented for the behavior of the anisotropy in these models. The contribution of the collisionless radiation to the motion of the anisotropy is given by the appearance of a term proportional to V_ν in the Lagrangian. The meaning of the angular momentum constraints embodied in the $T_{0i} = G_{0i}$ equations is discussed. The behavior of the models in the large anisotropy regime in terms of "wall collisions" is analyzed. The geodesic equation is discussed and it is shown that it can be reduced to a one-dimensional time-dependent Hamiltonian system. It is shown that, in the large-anisotropy regime, certain parameters of the geodesic motion are essentially constant if cosmological parameters were the same in the distant past as they are today. This is taken to suggest that dissipation may have occurred in the interim to change those parameters. (auth)

2755 CLOSED ROTATING COSMOLOGIES CONTAINING MATTER DESCRIBED BY THE KINETIC THEORY. B: SMALL ANISOTROPY CALCULATIONS; APPLICATION TO OBSERVATIONS. Matzner, Richard A. (Univ. of Texas, Austin. Wesleyan Univ., Middletown, Conn.). Ann. Phys. (N. Y.); 65: No. 1-2, 482-505(15 Jun 1971).

An explicit small anisotropy model is presented, taking parameters suggested by the observed Universe. An explicit discussion of the geodesic equation in the small-anisotropy regime is given, with applications to the microwave temperature anisotropy. The amplitude of the temperature anisotropy, $\Delta T/T$, is of the same order as predicted by Misner for Type I cosmologies, i.e., $\Delta T/T \sim 10^{-4}$ or smaller, assuming that neutrino dissipation processes were effective at $T \sim 10^{10}$K. It is shown that deviations from the lowest-order anisotropy shape (quadrupole + dipole) take the form of distortions of the anisotropy pattern over angular regions $\Delta\omega$ of the order of $\sim|\beta|$ where $|\beta|$ is a measure of the metric anisotropy.

Since $\Delta T/T$ is given by changes in the metric anisotropy since the last photon scattering, it is not directly correlated with $|\beta|$. The metric anisotropy need not be small and would be otherwise unmeasurable, so that it could give rise to large effects distorting the quadrupole $\Delta T/T$ shape. Observations on the (24-h) isotropy of the blackbody radiation put limits on the rotation in a realistic model, and hence the largest distorting effects are those that appear even in nonrotating models and are not directly related to rotation. Some calculations based on a moderate value for the metric anisotropy show that these effects might be detectable, but probably would be submerged in structure arising from local (i.e., noncosmological) effects or from other possible cosmological effects ignored in the homogeneous models. It is possible that the entire temperature anisotropy will be dominated by these nonhomogeneous or noncosmological effects. (auth)

2756 QUALITATIVE COSMOLOGY: DIAGRAMMATIC SOLUTIONS FOR BIANCHI TYPE IX UNIVERSES WITH EXPANSION, ROTATION, AND SHEAR. I. THE SYMMETRIC CASE. Ryan, Michael P. Jr. (Univ. of Maryland, College Park). Ann. Phys. (N. Y.); 65: No. 1-2, 506-37(15 Jun 1971).

By means of mathematical techniques due to Arnowitt, Deser, and Misner, the problem of universes that exhibit simultaneously expansion, rotation, and shear was investigated. A solution of the Einstein equation was obtained for such a Universe whose three-space sections are spaces of Bianchi type IX in the sense of a pictorial or diagrammatic solution. It is shown by means of this solution that the singularity in this case is very close in character to that of universes that have only expansion and shear, i.e., rotation changes the singularity very little. (auth)

2757 EXACT SOLUTIONS TO BRANS–DICKE COSMOLOGIES IN FLAT FRIEDMANN UNIVERSES. Morganstern, R. E. (Lunar Science Inst., Houston, Tex.). Phys. Rev., D; 4: No. 4, 946-54(15 Aug 1971).

The Brans–Dicke (BD) cosmological equations for flat Friedmann-type expanding universes with $p = \epsilon\rho$ are solved parametrically for time $t(z)$, density $\rho(z)$, expansion parameter $a(z)$, and scalar field $\lambda(z)$. These results reduce to a previously obtained exact solution to the radiation cosmology when $\epsilon = \frac{1}{3}$. Furthermore, asymptotically they reduce to the simple power-law solutions discussed in another paper. Moreover, it is found that in the limit as $a \to 0$ these solutions have characteristics similar to the radiation solutions in the same limit. In particular, the result that the scalar-field energy density dominates the radiation energy density as one approaches the initial singularity may be extended to all Friedmann models in the BD theory. Finally, as $t \to \infty$ it is found that the fractional change in the gravitational constant at the present epoch is $\dot{\lambda}_0 \lesssim 10^{-11}$/yr for a Hubble age $t_H = 4 \times 10^{17}$ sec and that this limit decreases with increasing pressure, becoming extremely small for a radiation cosmology. Hence, although the scalar field may be undetectable at the present epoch, if it exists it must play an important role as one approaches the initial singularity of the cosmology. (auth)

2758 AGING OF AN ELECTROMAGNETIC WAVE GROUPS. Hornbostel, Richard S. (Cosmair Inc., Clark, N. J.); Marcinkowski, Chester J. Phys. Rev., D; 4: No. 4, 931-46(15 Aug 1971).

The reason for the existence of the extragalactic redshift has been an interesting problem in astrophysics for some time. One proposed solution has been to assume that this redshift is simply a Doppler effect. Another assumption has been to suppose that the extragalactic light is somehow progressively "aged" by being shifted towards the red as the light from a distant galaxy moves towards the Earth. But the aging property proposed for producing this redshift may merely be assumed without postulating any specific mechanism. Alternatively, it has been assumed that the physical "constants" vary with time in such a way as to produce a cosmological redshift. An apparently new mechanism for producing a redshift is suggested here, based upon the "aging" properties of an electromagnetic wave group. In view of the cosmological importance of the redshift such a new mechanism may be of interest in astrophysics. (W.D.M.)

2759 MEASUREMENT OF THE ISOTROPY OF THE COSMICMICROWAVE BACKGROUND AT A WAVELENGTH OF 3 CM. Henry, Paul Shala. Princeton, N. J.; Princeton Univ. (1971). 166p. University Microfilms Order No. 71-23,361.

Thesis.

The large-scale ($l = 1$) cosmic-background anisotropy has been measured several times, but always with Earth-bound radiometers. Such instruments are profoundly influenced by radiation from the Earth's atmosphere, which results in increased stochastic and systematic errors. The most severe limitation of these experiments has been their inability to determine the polar component of the anisotropy. A balloon-borne radiometer, flown at 24-km altitude, was used to overcome this problem. The performance requirements for a Dicke radiometer are discussed. Fundamental noise limitations are given quantitative formulation, and practical design techniques are illustrated. The search for systematic errors in the data is described in some detail. All known sources of microwave emissions were investigated. Most of the terrestrial radiation is stopped by shields at the antennas, but radiation from the Galaxy cannot be shielded away; it must be estimated and its contribution subtracted from the data. The effect of the Earth's magnetic field on microwave ferrites is explained, along with a procedure for combatting this source of error. The data were analyzed for evidence of an $l = 1$ anisotropy and a significant effect, consistent with the results of earlier investigators, was found. In addition, the first radiometric determination of the polar component of the anisotropy was made. Its value was estimated to be roughly the same as the equatorial component. The parameters characterizing the $l = 1$ anisotropy were estimated to be: $10\frac{1}{2} \pm \frac{1}{4}$ hours, $-30° \pm 25°$, 3.2 ± 0.8 millidegrees Kelvin. A treatment of the uncertainties in these results is presented. (Diss. Abstr. Int., B)

2760 PART I. THE NON-LINEAR GROWTH OF DENSITY PERTURBATIONS IN HOT BIG-BANG COSMOLOGY. PART II. THE ANGULAR MOMENTUM AND BINDING ENERGY OF GALAXIES. Smith, Carl Ray. College Park, Md.; Univ. of Maryland (1971). 108p. University Microfilms Order No. 71-24,289.

Thesis.

The two investigations presented are unified by their objective to gain understanding about the origin and formation of galaxies. Part I treats perturbations to the cosmological background density after decoupling. It is known that, for a flat power spectrum of density fluctuations prior to recombination, the typical perturbations emerging after decoupling contain $\sim 10^5 M_\odot$. Thereafter, the first-order power spectrum retains its shape. The second-order power spectrum was calculated and found to peak at about one-half the first-order maximum-power wavelength. This most probably represents a contraction of the existing objects. There is a negative contribution on scales intermediate between globular cluster and typical galaxy masses and a positive contribution on larger scales. But the power in both cases is three to four orders of magnitude below the first-order power at those wavelengths. It is concluded that there is no significant tendency for the smaller-sized perturbations to interact to form larger objects. In Part II the observational data on the angular momentum L and binding energy E of galaxies are collected and, in agreement with previous studies, it is found that the approximate power laws with mass, $L \propto M^{\frac{5}{3}}$ and $E \propto M^{\frac{5}{3}}$, are followed. In addition, it is found that the deviations from these average relations are correlated with the Galaxy's intrinsic color, which is taken to be a quantitative measure of evolutionary age. "Older" systems have less angular momentum and more binding energy than "younger" galaxies of the same mass. It is shown that the virial theorem for a uniformly rotating, uniform-density spheroid relates the pressure in the equilibrium state to a positive power of $E/M^{\frac{5}{3}}$ (and a negative power of $L/M^{\frac{5}{3}}$). On the assumption of isothermal collapse at a universal temperature and using the fact that the rate of star formation increases with the density of the gaseous medium, it is concluded that this simple model for collapse predicts a relation of the type found statistically. (Diss. Abstr. Int., B)

2761 COUNTS OF RADIO SOURCES AT 6-CENTIMETER WAVELENGTH. Kellermann, K. I. (National Radio Observatory, Green Bank, W. Va.); Davis, M. M.; Pauliny-Toth, I. I. K. Astrophys. J.; 170: No. 1, L1-5(15 Nov 1971).

Counts of radio sources at 6 cm down to a source density of 5×10^3 sources per steradian show no compelling evidence that the space density of powerful radio sources depends strongly on epoch. (auth)

2762 NIGHT SKY DARKNESS IN THE EDDINGTON–LEMAITRE UNIVERSE. Pegg, David T. (James Cook Univ., Townsville, Australia). Mon. Notic. Roy. Astron. Soc.; 154: No. 3, 321-7(1971).

The well-known Olbers paradox argument precludes static model universes in which the stars have always shone. In such universes there would be no difference between day and night. This paper shows that an expanding Eddington–Lemaître universe in which stars have been radiating indefinitely can also be rejected on similar grounds. Just as the static model can be saved by assuming that the stars have been shining for only the last 10^{10} yr of the life of the Universe (Bonnor), so too can the Eddington–Lemaître model. (auth)(UK)

2763 LOCAL LUMINOSITY FUNCTION AND SECULAR EVOLUTION OF EXTRAGALACTIC RADIO SOURCES. Davidson,

W. (London Univ.). Mon. Notic. Roy. Astron. Soc.; 154: No. 3, 339-42(1971).

It is argued that recent criticisms of an earlier paper (Davidson [Nature, London, 227: 357(1970)]) by Longair and Scheuer (Mon. Nobic. Ray. Astron. Soc.; 151: 45 (1970)) are unfounded. The count models of Doroshkevich, Longair, and Zeldovich (Mon. Nobid. Ray. Astron. Soc.; 147: 139(1970)) are shown to be based on the wrong luminosity function and an incorrect evolutionary theory for the radio source population. (auth)(UK)

Planetary Phenomena

2764 (COO-382-109) ELEMENTS DEPLETED ON LUNAR SURFACE: IMPLICATIONS FOR ORIGIN OF MOON AND METEORITE INFLUX RATE. Anders, Edward; Laul, J. C.; Keays, Reid R.; Ganapathy, R.; Morgan, John W. (Chicago Univ., Ill. Enrico Fermi Inst. Chicago Univ., Ill. Dept. of Physics). [1970]. Contracts AT(11-1)-382; NAS-9-7887. 10p. (EFI-71-2; CONF-710102-3). Dep. NTIS.

From second annual lunar science conference; Houston, Tex. (Jan 1971).

Fifteen trace elements in lunar samples were measured, using neutron activation analysis procedures described previously (Keays et al., 1971). Results on Apollo 12 samples are shown. Some of these have already been published (Ganapathy et al., 1970a; Laul et al., 1970; Morgan et al., 1970). Results are given from an analysis of several Apollo 11 samples. (W.D.M.)

2765 THEORY OF IO'S EFFECT ON JUPITER'S DECAMETRIC EMISSIONS. McCulloch, P. M. (Univ. of Tasmania, Hobart, Australia). Planet. Space Sci.; 19: No. 10, 1297-1312(Oct 1971).

The effect of Io on Jupiter's decametric emissions is explained by a disturbance generated at Io, and coupled to streams of moderately relativistic electrons close to Jupiter that emit cyclotron radiation. The coupling occurs through whistler-mode electromagnetic waves that interact with the electron streams by means of the gyroresonant interaction. Predicted distributions of emission probability and power are given as a function of Io's departure from superior geocentric conjunction and Io's magnetic longitude. A map of emission as a function of Io's departure from superior geocentric conjunction and Jupiter's longitude is given for frequencies greater than 30 MHz. The effect of Io on early-source dynamic spectra is considered. (auth) (UK)

2766 Rb-Sr AGES OF IGNEOUS ROCKS FROM THE APOLLO 14 MISSION AND THE AGE OF THE FRA MAURO FORMATION. Papanastassiou, D. A.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett.; 12: No. 1, 36-48(Sep 1971).

Internal Rb-Sr isochrons were determined on four basaltic rocks and on a basaltic clast from a breccia from the Fra Mauro landing site. Rocks 14310, 14073, and 14001,7,3 yield essentially identical ages T = 3.88 ± 0.04 AE and identical high initial $^{87}Sr/^{86}Sr$, I = 0.70035 ± 4. Rock 14053 and the clast from breccia 14321 both yield a higher age T = 3.95 ± 0.04 AE and a distinctly lower I = 0.69945 ± 4. Model ages relative to BABI for these rocks range from 4.3 to 4.6 AE. Model ages were determined for soil samples 14141, 14149, 14163, 14259 yielding T_{BABI} of 4.4, 4.5, 4.5, and 4.7 AE respectively. An internal isochron was determined for 12004 and yielded (3.29 ± 0.07 AE, 0.69948 ± 5) in agreement with previous results for basaltic rocks from the Apollo 12 site. (auth)

2767 PETROLOGIC AND MINERALOGIC INVESTIGATION OF SOME CRYSTALLINE ROCKS RETURNED BY THE APOLLO 14 MISSION. Gancarz, A. J.; Albee, A. L.; Chodos, A. A. (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett.; 12: No. 1, 1-18(Sep 1971).

Apollo 14 crystalline rocks (14053 and 14310) and crystalline rock fragments (14001,7,1; 14001,7,3; 14073; 14167,8,1, and 14321,191,X-1) on which Rb/Sr, $^{40}Ar-^{39}Ar$, or cosmic-ray exposure ages had been determined were studied with the electron microprobe and the petrographic microscope. Rock samples 14053 and 14310 are mineralogically and petrologically distinct from each other. On the basis of mineralogic and petrologic characteristics all of the fragments, except 14001,7,1, are correlative with rock 14310. Sample 14073 is an orthopyroxene basalt with chemical and mineralogic affinities to "KREEP", the "magic" and "cryptic" components. Fragment 14001,7,1, is very similar to Luny Rock I. (auth)

2768 APOLLO 14: NATURE AND ORIGIN OF ROCK TYPES IN SOIL FROM THE FRA MAURO FORMATION. Earth Planet. Sci. Lett.; 12: No. 1, 49-54(Sep 1971).

Compositions of glasses in the Apollo 14 soil correspond to four types of Fra Mauro basalts, to mare basalts and soils, and, in minor amounts, to gabbroic anorthosite and potash granite. The Fra Mauro basalts can be related by simple low-pressure crystal-liquid fractionation that implies a parent composition like that of Apollo 14 sample 14310. (auth)

2769 AGE OF THE FRA MAURO FORMATION: A RADIOMETRIC OLDER LIMIT. Compston, W.; Vernon, M. J.; Berry, H.; Rudowski, R. (Australian National Univ., Canberra). Earth Planet. Sci. Lett.; 12: No. 1, 55-8(Sep 1971).

The internal Rb-Sr age of a 0.17-g basaltic clast from an Apollo 14 breccia is 4.15 ± 0.10 by. This limits the Imbrium event to not older than 4.25 by on-current interpretations of lunar stratigraphy. (auth)

2770 MIXING MODELS AND RECOGNITION OF END-MEMBER GROUPS IN APOLLO 11 AND 12 SOILS. Lindsay, John F. (Manned Spacecraft Center, Houston, Tex.). Earth Planet. Sci. Lett.; 12: No. 1, 67-72(Sep 1971).

Lunar soils returned from the Apollo 11 and 12 sites appear to consist of more than one source material. Investigators have suggested that the soil can be described by as few as two end members and possibly as many as five or six. In the present study Q-mode factor analysis was used to establish the end members more rigorously and suggests that major-element chemistry of Apollo 11 and 12 lunar soils can be adequately explained in terms of a three-component mixing system. The end members isolated by Q-mode factor analysis can be regarded as basaltic, anorthositic, and noritic (or KREEP) components. Three-component mixing models fitted by least squares to the eight major oxides indicate that six of the Apollo 12 soils investigated are dominated by the basaltic component, whereas the other five are dominated by the noritic or KREEP component. Anorthosite is present in all soils except sample 12033, which is a simple two-component mixture of basalt and KREEP. The Apollo 11 soil is also a three-component mixture but is more basaltic than the Apollo 12 soils. Anorthositic and KREEP materials are important components of the lunar lithosphere and may be distributed on the lunar surface areally in an independent manner. (auth)

2771 JUPITER'S DECAMETRIC FLUX: A CONSISTENT TWO-DIMENSIONAL ANALYSIS, 1957-1970. Miller, Hugh Richard. Gainesville, Fla.; Univ. of Florida (1970). 255p. University Microfilms Order No. 71-24,439.

Thesis.

The decametric radiation from Jupiter received from 1957 to 1969 at the University of Florida and its associated field station located at Maipu, Chile, was analyzed at frequencies ranging from 15 to 27.6 MHz. A consistent analysis of the flux density was undertaken for approximately seventy-five yearly sets of data in order that the individual and joint effects of several geometrical parameters could be determined. A two-dimensional analysis of the flux density as a simultaneous function of the longitude of the central meridian and the position of Io from superior geocentric conjunction was made. A definite symmetry about the Earth-Jupiter line was observed which appears to be associated with these four sources. The two-dimensional analysis of the flux density was also used in an attempt to determine if there exist simultaneous favorable positions of Io and Europa and Io and Ganymede for which the intensity of the radiation in enhanced. It appears that there is no significant effect due either to Europa or Ganymede. A study was made of the flux density versus sunspot number, Jovicentric declination of the Earth, and brightness of the coronal 5303 Å line (used as an alternative index of solar activity), in an attempt to determine which of these parameters appears to have more influence on the observed 11-year cycle of the Jovian radiation probability. A pulse-height analysis of the Jupiter flux data was also carried out. (TSS) (Diss. Abstr. Int., B)

2772 CALCULATION OF THE LUNAR PHOTON ALBEDO. Armstrong, T. W. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 906-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2773 COMPOSITIONAL VARIATIONS IN LUNAR SPINELS. Haggerty, S. E. (Univ. of Massachusetts, Amherst). Nature (London) Phys. Sci.; 233: No. 43, 156-60(25 Oct 1971).

A detailed discussion is presented on the variations in composition in lunar spinels from Apollo 11, 12, and 14 missions. Electron-microprobe analyses revealed that: four distinct compositional trends and three prominent compositional discontinuities are in evidence; both ionic and coupled substitution are active during crystallization, and the extent of ionic substitution is related to the degree of coupled substitution in the ulvospinel-chromite series; and that substitution in general may be fO_2-

dependent. Analytical determinations on the ulvospinel–chromite group indicated that there is a complete solid solution series between these two end members. Differences in samples from the various Apollo missions are discussed. The series is not a simple binary, and is complicated still further by having a mixed spinel structure. Compositional diagrams are shown and discussed. The important substitutional process is evident in lunar spinels: Fe + Ti for 2 Cr; Mg for Fe; and Cr for Al. It is concluded that compositional variations in the lunar spinel group are more complex than has hitherto been realised. Whether the chromite–ulvospinel series and the complexity of lunar spinels are a reflection of varying degrees of fractional crystallization or partial melting, or whether their stability and the sequence of crystallization are simply T and fO_2-dependent, must await quantitative determinations. (UK)

Atomic and Molecular Physics

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstract 3074.

2774 QUANTUM MECHANICS OF IDENTICAL PARTICLES. II. Ohnuki, Y. (Nagoya Univ., Japan); Kamefuchi, S. Ann. Phys. (N. Y.); 65: No. 1-2, 19-34(15 Jun 1971).

The first-quantized formalism for paraparticles, which was developed in previous papers, is investigated further with emphasis on permutation operators. Four different kinds of permutation operators are introduced, all of which act on the arguments of wave functions. The correspondence is established between the first- and second-quantized formalisms, and on this basis the problem of observability of these permutation operators is discussed. An outline is also given of a first-quantized formalism for particles that do not obey the ordinary parastatistics. (auth)

2775 NONLINEAR DOUBLE-TIME GREEN FUNCTIONS IN QUANTUM STATISTICAL MECHANICS. Tani, K. (Kyoto Univ.). Phys. Lett.; 37A: No. 2, 97-9(8 Nov 1971).

A new method to evaluate the correlation function describing nonlinear response with respect to the strengths of external disturbance is developed. (auth)

2776 SOURCE OF POLARIZED ELECTRONS USING SPIN EXCHANGE. Campbell, D. M.; Brash, H. M.; Farago, P. S. (Univ. of Edinburgh). Phys. Lett.; 36A: No. 6, 449-50(11 Oct 1971).

From a source in which trapped electrons interact with a polarized potassium beam, a pulsed electron beam is extracted with up to 50% polarization. Values of the spin exchange cross section at electron energies of 1, 2.5, and 4 eV are derived. (auth)

2777 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 6, NO. 8, 1971. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 57p.

This listing contains 207 references on various aspects of surface and vacuum physics. (M.O.W.)

2778 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 6, NO. 9, 1971. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 59p.

This listing contains 190 references on various aspects of surface and vacuum physics. (M.O.W.)

2779 MULTIPLE SCATTERING OF LITHIUM IONS WITH ENERGIES FROM 10 TO 50 keV IN VARIOUS TARGET MATERIALS. Schwabe, S.; Stolle, R. (Humboldt Univ., Berlin). Phys. Status Solidi (b); 47: No. 1, 111-18(1 Sep 1971).

Experimental results are reported regarding the multiple scattering of lithium ions with energies from 10 to 50 keV in carbon, aluminum, silicon, vanadium, chromium, iron, cobalt, and germanium. The targets consisted of thin self-supporting foils 150 to 700 Å thick. The results of the scattering measurements agree satisfactorily with Meyer's theory of multiple scattering with regard to the dependence on the energy of the ions, foil thickness, and the form of the scattering distribution. (auth)

2780 ENERGY SPECTRA OF keV BACKSCATTERED PROTONS AS A PROBE FOR SURFACE-REGION STUDIES. Van Wijngaarden, A.; Miremadi, B.; Baylis, W. E. (Univ. of Windsor, Ont.). Can. J. Phys.; 49: No. 19, 2440-8(1 Oct 1971).

Energy spectra were measured of ^1H and ^4He projectiles backscattered from thin Au films of known thicknesses. An analytical expression for the spectra is derived in the limit of no multiple scattering. Protons of energies ~50 keV are shown to give resolutions of a few Å for depth measurements up to about 500 Å, thus providing a useful technique for studying surface regions. The technique is illustrated by measurements of a nickel film before and after oxidation. Stopping cross sections for ^1H and ^4He in Au are obtained for energies $20 < E < 100$ keV. (auth) (Canada)

2781 BEAM-FOIL EXCITATION OF n = 5 AND n = 4 LEVELS OF He II. Spitzberg, Larry A. Houston, Tex.; Rice Univ. (1971). 125p. University Microfilms Order No. 71-26,362.

Thesis.

The distribution of the excited states in the n = 5 and n = 4 levels of He II was determined from measurements of the radiation from the $n = 5 \rightarrow 3$, $n = 4 \rightarrow 3$, and $n = 4 \rightarrow 2$ transitions. The populations of the orbital angular momentum states and the total populations in these levels were compared with the theory of Yager, which provides the only detailed model for the beam–foil excitation of He II. The results show that the free-carbon-atom model of Yager can correctly predict the relative populations in these levels. Absolute calibrations of the populations, however, have shown a much larger fraction of the beam in these levels than predicted by the theory. The magnitude of the de-excitation cross section used in the theory is shown to be too large. This change only affects the magnitude of the populations and would result in agreement between the theory and the present experiments. (Diss. Abstr. Int., B)

2782 LUMINESCENCE OF SLOW NEON PARTICLES THAT APPEARS DURING BOMBARDMENT OF A CARBON FILM BY A BEAM OF FAST NEON IONS. Gritsyna, V. V.; Kiyan, T. S.; Fogel, Ya. M.; Koval, A. G.; Klimovskii, Yu. A. Opt. Spectrosc. (USSR) (Engl. Transl.); 29: No. 4, 343-5(Oct 1970).

Translated from Opt. Spektrosk.; 29: No. 4, 641-3(Oct 1970).

An investigation of the luminescence of slow neon particles during bombardment of a carbon film by Ne^+ ions showed that under favorable conditions this luminescence appeared during bombardment of solid targets not only by Ne^+ ions but also by ions of other elements. (auth)

Atomic and Molecular Properties

Refer also to abstracts 2239, 2744, and 3174.

2783 (N–71-30917) LONG-RANGE ELECTROSTATIC AND ELECTROMAGNETIC INTERACTIONS BETWEEN ATOMS. Cortez, Jose Luis M. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). Jun 1971. 195p. (NASA-TR-R-367). NTIS.

The contribution to the interaction energy between two neutral hydrogenic atoms in their ground state due to their electrostatic interaction and the presence of an electromagnetic radiation field in the system is examined. The inclusion of the radiation field in the Hamiltonian of the system gives rise to retardation effects in the interaction energy, which are a function of the separation R between the atoms. These effects are unimportant for distances smaller than the wavelength lambda associated with the radiation being considered and increase in importance as R approaches lambda. In the case of atomic systems, the smallest wavelength associated with atomic transitions is large when compared to the atomic dimensions; hence, the problem can be treated using nonrelativistic quantum electrodynamics. This permits neglect of the particle spin and use of simple product eigenfunctions for the atomic and photon states. In addition, the above simplifications make it possible to treat the problem using standard nondegenerate perturbation theory. This feature is crucial since the calculation must be pushed to fourth order before obtaining nonzero corrections to the interaction energy due to the radiation field. (auth) (STAR)

2784 (ORNL-TM-3575) COMPUTER PROGRAM TO CALCULATE AUGER TRANSITIONS FOR A SURFACE CONTAINING SEVERAL KINDS OF ATOMS. Coghlan, W. A. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 50p. Dep. NTIS.

A computer program was written to calculate the energy of Auger electrons emitted from a surface containing several kinds of atoms. The transitions are listed in order of increasing energy and are plotted utilizing both the line printer and a Calcomp plotter. The program can be instructed to find all the possible transitions or, alternatively, find only those represented by 69 energy-level combinations that are thought to be the most prob-

able. The spectra have been calculated from the empirical expression $E_{Auger} = E_v - E_{x'} - E_{y'}$, where E_v is the energy of the initial electron vacancy, $E_{x'} = [E_x(z) + E_x(z+1)]/2$, and $E_{y'} = [E_y(z) + E_y(z+1)]/2$. $E_x(z)$ and $E_x(z+1)$ are the atomic binding energies for the x electron in atoms having atomic numbers z and z + 1, respectively. $E_y(z)$ and $E_y(z+1)$ are the same for the y electron. An example of the output for all the spectra and for the strong lines is given for a sample representing a stainless steel surface with spectra from C, O, S, Cr, Fe, and Ni. (auth)

2785 (ORNL-TM-3576) CATALOG OF CALCULATED AUGER TRANSITIONS FOR THE ELEMENTS. Coghlan, W. A.; Clausing, R. E. (Oak Ridge National Lab., Tenn.). Nov 1971. Contract W-7405-eng-26. 570p. Dep. NTIS.

The possible Auger transitions between 10 and 3000 eV for the elements from atomic number 3 through 92 have been calculated assuming 6000-eV incident electrons. The spectra have been calculated from the empirical expression $E_{Auger} = E_v - E_{x'} - E_{y'}$, where E_v is the binding energy of the initial electron vacancy, $E_{x'} = [E_{x(z)} + E_{x(z+1)}]/2$, and $E_{y'} = [E_{y(z)} + E_{y(z+1)}]/2$. $E_{x(z)}$ and $E_{x(z+1)}$ are the atomic binding energies for the x electron in atoms having atomic number z and z + 1, respectively. $E_{y(z)}$ and $E_{y(z+1)}$ are the same for the y electron. The spectra are listed in order of increasing atomic number with the transitions for each element identified and listed in order of increasing energy. (auth)

2786 MEASUREMENT OF THE $2^2S_{1/2}-2^2P_{\frac{1}{2}}$ INTERVAL IN ATOMIC HYDROGEN. Kaufman, S. L.; Lamb, W. E. Jr.; Lea, K. R.; Leventhal, M. (Yale Univ., New Haven). Phys. Rev., A; 4: No. 6, 2128-43(Dec 1971).

An experiment is described in which the two transitions $\alpha a(m_J = +1/2 \rightarrow +3/2)$ and $\alpha b(m_J = +1/2 \rightarrow +1/2)$ were employed to measure the interval $(\Delta E \rightarrow S)_H$. Hydrogen atoms in the metastable state are produced by bombarding molecular hydrogen with electrons within a waveguide in a magnetic field. An rf electric field in the guide induces electric dipole transitions from this state to the 2P states, and the 1216-Å radiation produced in the decay of the 2P state is detected. The frequency of the rf field is held constant, and the magnetic sublevels of the states involved are tuned by varying the magnetic field. When the resonance condition is met, the intensity of 1216-Å light increases. Precision measurements of signal versus magnetic field are fitted by least squares to a line-shape formula described in detail. Potential sources of systematic error and experimental searches for them are described. Small shifts are detected upon changing the electron-beam current and gas pressure, and an extrapolation is made to remove them. The weighted average of results from the two transitions is $(\Delta E - S)_H = 9911.377(26)$ MHz. A comparison is made with other recent experiments that have measured the same interval. (auth)

2787 SINGLET-TRIPLET MIXING IN EXCITED HELIUM ATOMS. Parish, R. Mel; Mires, Raymond W. (Texas Tech. Univ., Lubbock). Phys. Rev., A; 4: No. 6, 2145-60(Dec 1971).

Experiments in collisional transfer of excitation, as well as theoretical considerations, have shown that singlet–triplet mixing occurs for nF states of helium. In this work the helium fine structure was calculated using polarized orbitals to determine the amount of mixing and its dependence on the state (nl) of the excited electron, and on the polarization of the orbital of the inner electron. Results are presented for n = 3 to 10 and $l = 2(n-1)$. All P states gave poor results because of a large exchange effect involving the polarization term in the wave function. However, the 3^3D and 4^3D levels showed improved agreement with experiment for the fine structure. The singlet–triplet mixing is essentially zero for l = 2, is significant for l = 3, and is virtually complete for $l \geq 4$. It is also found that the mixing decreases slightly with increasing n. (auth)

2788 AUGER AND COSTER-KRONIG TRANSISTION PROBABILITIES TO THE ATOMIC 2s STATE AND THEORETICAL L_1 FLUORESCENCE YIELDS. Crasemann, Bernd (Univ. of Oregon, Eugene); Chen, Mau Hsiung; Kostroun, Vaclav O. Phys. Rev., A; 4: No. 6, 2161-4(Dec 1971).

Atomic L_1-level Auger and Coster–Kronig widths were calculated for 14 elements with $33 \leq Z \leq 85$. Nonrelativistic screened hydrogenic wave functions and j–j coupling were used; all pertinent transitions were included that involve final vacancy configurations through $f_{\frac{7}{2}}f_{\frac{7}{2}}$. With the aid of Scofield's x-ray emission rates, L_1 fluorescence yields are calculated. Total L_1, L_2, and L_3 level widths are compared. (auth)

2789 NONRELATIVISTIC AUGER RATES, X-RAY RATES, AND FLUORESCENCE YIELDS FOR THE 2p SHELL. Walters, D. L.; Bhalla, C. P. (Kansas State Univ., Manhattan). Phys. Rev., A; 4: No. 6, 2164-70(Dec 1971).

The Auger rates, x-ray rates, fluorescence yields, and Kα linewidths are presented for all elements Z = 12 through 55 and Z = 60, 65, 70, 75, 80, and 85 when a vacancy is in the 2p shell. Numerical calculations were performed using the Hartree–Fock–Slater approach with Herman, Van Dyke, and Ortenburger exchange. Comparisons of different exchange approximations on the Auger and x-ray total transition rates and the fluorescence yields are reported. (auth)

2790 FERMI CONTACT HYPERFINE CONSTANTS FOR RARE-EARTH ATOMS AND IONS FROM MOMENT-PERTURBED CALCULATIONS. Ikenberry, Dennis (Univ. of Utah, Salt Lake City); Das, T. P.; Mann, Joseph B. Phys. Rev., A; 4: No. 6, 2188-91(Dec 1971).

Moment-perturbed calculations were carried out for the Fermi contact hyperfine constant for a selection of rare-earth atoms and ions. In the cases of neutral and divalent europium, a value that has the same sign as the experimental value but is larger in magnitude was found. This is in disagreement with earlier published works of Bagus and Picart who, using an unrestricted Hartree–Fock approach, found a result of opposite sign compared to the experimental results. Results are presented for divalent, trivalent, and neutral ions and atoms, and trends are discussed. (auth)

2791 METASTABLE HYDROGEN MOLECULES. III. HYPERFINE STRUCTURE OF ORTHOHYDROGEN. Brooks, P. R. (Rice Univ., Houston, Tex.); Lichten, William; Reno, Richard. Phys. Rev., A; 4: No. 6, 2217-23(Dec 1971).

The fine structure (fs) and hyperfine structure (hfs) of the N = 1 rotational level of a single vibrational state of the $(1\sigma_g, 1\pi_u)c\ ^3\Pi_u$ state of orthohydrogen was measured by the molecular-beam magnetic-resonance method. Six independent frequency intervals were measured to a precision of better than one part per million. The theory of fs and hfs, as developed by Fontana, Chiu, Jette, and Cahill, was used to fit the energy levels with four accurate, independent constants: the spin–orbit fs constant, A = −3717.12 MHz; the spin–spin fs constant, $B_0 - \sqrt{6}B_2 = 9562.50$ MHz; the combined orbital and Fermi contact hfs constants, $\frac{1}{2}a + a_F = 463.77$ MHz; the dipolar hfs term, c − 3d = 104.18 MHz; and the fifth, very much less accurately determined, orbital hfs constant, a = 26.6 MHz. The Fermi contact constant $a_F = 450.5$ MHz agrees remarkably closely with the value 440.1 found in H_2^+ by Jefferts. This indicates that the contact hfs of this state arises largely from a single-core electron, which is virtually the same as in H_2^+. The agreement between experimental energy levels and the theoretical fit is very good. The deviations are at worst 20 kHz, only a few parts per million in the measured intervals. If the previously measured fs of the N = 2 state is used, the spin–spin constants become $B_0 = -1420$ MHz, $B_2 = -4480$ MHz. The spin–orbit constants for the N = 1 and N = 2 levels disagree by 3%. The constants $\frac{1}{2}a + a_F$ and c − 3d disagree by several percent with a priori calculations by Jette. The level of discrepancies among different experimental and theoretical results is an order of magnitude larger than can be obtained within the framework of the pure case-b coupling scheme. Evidence is found for nonadiabatic transitions of a new type for molecular-beam experiments. The discovery of new transitions proves that there is more than one metastable vibrational level of the $c\ ^3\Pi_u$ state of H_2. It is likely, although not certain, that the present data are from the lowest (v = 0) level. (auth)

2792 FINE-STRUCTURE MEASUREMENTS BY THE BEAM-FOIL TECHNIQUE. Berry, H. G.; Subtil, J. L. (Laboratoire de Physique de l'Atmosphere, Villeurbanne, France). Phys. Rev. Lett.; 27: No. 17, 1103-4(25 Oct 1971).

Fine-structure separations in some ^3P states of He I (n = 3, 4, 5) and Li II (n = 4, 5) were measured by observation of modulated light-intensity decay curves using the beam–foil technique. (auth)

2793 VARIATIONAL NONRELATIVISTIC CALCULATIONS FOR THE $(2pnp)^{1,3}P^e$ STATES OF TWO-ELECTRON ATOMIC SYSTEMS. Holoeien, E.; Midtdal, J. (Univ. of Oslo). J. Phys., B (London); 4: No 10, 1243-9(Oct 1971).

The Rayleigh–Ritz variational method utilizing the Sturmian–Legendre basis set was applied to doubly excited P states of even parity of the He I isoelectronic sequence in order to obtain nonrelativistic energy positions of the lowest-lying states. The states themselves are of physical interest to study since they are metastable against autoionization within the LS coupling approximation. The energy positions are of importance as initial states for electronic transitions now being studied by the beam–foil technique. For helium the wavelengths of possible allowed transitions and the corresponding wave functions are given. A comparison of the results with those obtained by other theoretical calculations is also included. (auth) (UK)

2794 THIRD-ORDER HARTREE–FOCK ENERGY FOR THE $1s2s\ ^{1,3}S$ STATES OF HELIUM-LIKE IONS. Wilson, R. G. (Bir-

beck Coll., London); Eliezer, I. J. Phys., B (London); 4: No. 10, 1255-6(Oct 1971).

The errors in an earlier calculation of the third-order Hartree–Fock energy for the $1s2s^{1,3}S$ states of helium-like ions are corrected. (auth) (UK)

2795 LONG-RANGE INTERACTIONS AMONG He AND Be ATOMS. Arrighini, G. P. (Univ., Pisa, Italy); Biondi, F.; Guidotti, C. J. Chem. Phys.; 55: No. 8, 4090-5(15 Oct 1971).

Long-range dispersion energies for the atom pairs He–He, He–Be, and Be–Be in their ground states were calculated in the form $E_{disp} = C_6/R^6 + C_8/R^8 + C_{10}/R^{10} + C_{11}/R^{11} + C_{12}/R^{12}$, the coefficients C_n being obtained from the appropriate dynamic polarizabilities at imaginary frequencies. The needed polarizabilities of imaginary argument were calculated within the time-dependent coupled Hartree–Fock approximation. Three-body nonadditive contributions to the interaction energies were also evaluated. (auth)

2796 HYPERFINE PRESSURE SHIFT OF HYDROGEN IN HELIUM. Kunik, Dan; Kaldor, Uzi (Tel-Aviv Univ., Israel). J. Chem. Phys.; 55: No. 8, 4127-31(15 Oct 1971).

The hyperfine pressure shift of hydrogen atoms in a helium atmosphere is calculated over a wide temperature range (50 to 700°K). Results are not very sensitive to the exact form of the H–He potential, but depend strongly on the values of the spin density at the hydrogen nucleus at different H–He interatomic separations. Spin densities are evaluated by the spin-optimized self-consistent-field method and are corrected for the long-range Van der Waals interaction. It is argued that long-range spin density shifts are indeed negative as suggested by several previous calculations, in contrast with a recent five-configuration treatment. The present results are 20 to 25% higher than experimental values. Most of the error is attributed to the uncertainties concerning the method of including long-range effects. (auth)

2797 PRESSURE-BROADENED LINEWIDTHS IN ELECTRIC-FIELD-INDUCED SPECTRUM OF D_2. Robertson, Charles W. (Florida State Univ., Tallahassee); Hunt, Robert H.; Brannon, Paul J. J. Chem. Phys.; 55: No. 8, 4149-40(15 Oct 1971).

Pressure-broadened linewidths in the electric-field-induced Q branch of the 1–0 band of D_2 are reported. Within the error of measurement, all points on a plot of linewidth vs density lie on straight lines passing through the origin. The measured values are in reasonable agreement with values calculated by the theory of Van Kranendonk. (A.G.W.)

2798 $(n^{12})^1S$ AUTOIONIZING STATES OF HELIUM. Ramaker, David Ellis. Iowa City, Iowa; Univ. of Iowa (1971). 281p. University Microfilms Order No. 71-22,079.

Thesis.

The method of configuration interaction (CI) as applied to autoionization by Fano was generalized allowing the initial basis set, the bound and continuum components, to be chosen for convenience. Thus the prediagonalization procedure required by the Fano theory was eliminated, greatly increasing the utility of the CI method. The effects of near-neighbor resonance interactions were incorporated into the theory and were found to be the factor distinguishing the Feshbach and Seigert definitions for the resonance states. As a first step in estimating the applicability of the generalized CI method for calculating positions and widths of autoionizing levels of atoms and molecules, an investigation of the helium problem was completed and is reported here. Resonance energies, widths, relative probabilities for decay to the degenerate channels, and Fano–Cooper cross-section parameters are obtained for the $(nl^2)^1S$ autoionizing states with $n = 1(1)4$, $l \leq 3$ and $n = 5$, $l \leq 2$ having energies in the range 57.96 to 76.06 eV above the ground state (i.e., the region in which the n = 1, 2, 3, and 4 channels are open). (TSS)(Diss. Abstr. Int., B)

2799 HIGH-RESOLUTION ATOMIC-ABSORPTION SPECTRA OF URANIUM OBTAINED BY THE FLASH-PHOTOLYSIS AND FLASH-DISCHARGE TECHNIQUES. Radziemski, Leon J. Jr.; Steinhaus, David W.; Engleman, Rolf Jr. (Los Alamos Scientific Lab., N. Mex.). J. Opt. Soc. Amer.; 61: No. 11, 1538-9(Nov 1971).

Atomic absorption spectra of uranium were obtained at temperatures lower than those used in uranium-furnace experiments by the techniques of flash photolysis and flash discharges. UI_4 was used in the flash-photolysis experiment, and UF_6 was used in the flash-discharge apparatus. Information on seven lines assigned to U I and U II is tabulated. (A.G.W.)

2800 VALIDITY OF FUNDAMENTAL IONIZATION DATA FOR ELECTRONS AT HIGH VALUES OF E/p. Folkard, M. A.; Haydon, S. C. (Univ. of New England, Armidale, Australia). Aust. J. Phys.; 24: 519-26(Aug 1971).

The nonequilibrium nature of ionization growth at high mean electron energies is discussed. The need for high precision in the measurement of ionization currents is demonstrated and such measurements show that for E/p values $\gtrsim 300$ V cm^{-1} torr^{-1} an equilibrium situation is never attained for electrons in hydrogen. Published data for this and other gases must therefore be reassessed. (auth) (Australia)

2801 INVESTIGATION OF THE INFLUENCE OF NON-EQUILIBRIUM EFFECTS ON THE GROWTH OF IONIZATION IN HYDROGEN. Folkard, M. A.; Haydon, S. C. (Univ. of New England, Armidale, Australia). Aust. J. Phys.; 24: 527-42(Aug 1971).

The growth of ionization in molecular hydrogen was re-examined for $50 < E/p < 1400$ V cm^{-1} torr^{-1}. A high degree of precision was achieved in the ionization measurements through precise control of the electrode alignment. The influences of a number of competing nonequilibrium effects were thus resolved, and evidence was obtained that electrons with high mean energies appropriate to $E/p \gtrsim 300$ V cm^{-1} torr^{-1} do not achieve equilibrium in their transit across the ionization region. Detailed data on ionization growth are presented and, where possible ($E/p \leq 250$ V cm^{-1} torr^{-1}), values of the ionization coefficients are tabulated. For the quasi-equilibrium region, $300 < E/p < 500$ V cm^{-1} torr^{-1}, the values quoted for the effective ionization coefficients are shown to depend on the precision of the current measurements. Beyond $E/p \sim 500$ V cm^{-1} torr^{-1}, where nonequilibrium conditions prevent the evaluation of a spatially independent ionization coefficient, information is provided in the form of current–voltage plots. The experimental observations are in general agreement with Monte Carlo calculations of the ionization growth. (auth) (Australia)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 3199 and 3658.

2802 (JINR-P14-6023) ON THE MECHANISM OF THE μ-MESON DEPOLARIZATION IN THE MOLECULAR CONDENSED MEDIA. Dzhuraev, A. A.; Evseev, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

The influence of fast chemical reactions of a mesic atom on the negative muon depolarization is considered in relation to the concept of a "Coulomb explosion" occurring because of the high polarization of a molecule at Auger transitions. It is shown that the experimentally obtained dependence on temperature of the residual depolarization of muons on capture in water corresponds to the average time when a produced mesic atom enters chemical combination in the range from $(8.3 \pm 1.2) \times 10^{-12}$ sec for 80°K to $(2.5 \pm 0.4) \times 10^{-12}$ sec for 273°K. (auth)

2803 X-RAY YIELDS FROM PIONIC HYDROGEN. Leon, M. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Lett.; 37B: No. 1, 87-8(1 Nov 1971).

The K x-ray yields from π^- capture in gaseous hydrogen are calculated. While the calculated value for the total K yield (per π^-p reaction) agrees fairly well with the experimental value of Bailey that for the relative K_α yield does not. (auth)

2804 PHENOMENOLOGICAL CALCULATION OF VACUUM FLUCTUATION IN ELECTRONIC AND MUONIC ATOMS. Fricke, B. (Northwestern Univ., Evarston, Ill.). Lett. Nuovo Cim.; 2: No. 6, 293-6(7 Aug 1971).

A simple folding method for calculating vacuum fluctuation in electronic and muonic atoms is described. Results for H, He^+, Li^{2+}, C^{5+}, Z = 70, Z = 80, Z = 90, and muonic Ca and U are tabulated and compared with exact calculations of others. The agreement for the electronic atoms is considered good in the low-Z region. For the muonic atoms, the results are of the same order of magnitude as results of exact calculations. An attempt to extrapolate to elements up to Z = 180 indicates that the proposed method will lead to the right order of magnitude for superheavy elements. (A.G.W.)

2805 STRUCTURE OF NEUTRAL MESONIC ATOMS FORMED IN LIQUID HELIUM. III. MORE ACCURATE TREATMENT OF THE ELECTRON WAVEFUNCTION. Chen, L. C.; Guo, J.; Russell, J. E. (Univ. of Cincinnati). J. Math. Phys. (N. Y.); 12: No. 9, 1906-13(Sep 1971).

The ground-state energy of a spinless nonrelativistic electron in the field of two fixed spinless nuclei with charges +2 and −1 is computed exactly for a large number of values of the internuclear separation. The calculation is performed using a method devised many years ago by Baber and Hassé. The results of this calculation are then used to estimate values, for a few highly excited

states of $\alpha\pi^-e^-$ and αK^-e^- atoms, of a correction to a previous calculation of the binding energy. This energy correction increases, by one unit, a previous estimate of the multipolarity of the most-favored Auger transition from a circular orbit of the αK^-e^- atom with n = 29; a similar increase is found to be most likely for circular orbits of the $\alpha\pi^-e^-$ atom with n = 20 and circular orbits of the $\alpha\bar{p}e^-$ atom with n = 32, 35, and 37. For αK^-e^- atoms with n = 27 and 29, the energy corrections cause the calculated energy difference between a circular and a nearly circular orbit with the same principal quantum number to be between 15 and 30% smaller than had been estimated previously. Two other corrections are estimated and are found to be probably negligible. One of these corrections is the inaccuracy in the calculated binding energy of a helium-like mesonic atom, as obtained using the Born–Oppenheimer approximation, which is associated with the angular correlation between the positions of the electron and the meson. The other correction is the change in the computed value of the mean meson orbital radius, which occurs when the interactions responsible for the electron–meson angular correlation are taken into account. (auth)

2806 TEMPERATURE DEPENDENCE OF THE LIFETIME OF TRIPLET POSITRONIUM IN ALIPHATIC HYDROCARBONS AND THEIR DERIVATIVES. Buchikhin, A. P.; Gol'danskii, V. I.; Shantarovich, V. P. (Inst. of Chemical Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 13: No. 11, 444-7(5 Jun 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 11, 624-7(5 Jun 1971).

The temporal distribution of positron annihilation in n-hexadecane, n-octane, n-propanol, and ethanol at temperatures from −20 to 100°C was measured. The bubble model was then used to calculate the dependence of the lifetime on temperature for each case. The agreement obtained between the experimental and theoretical results leads to two conclusions: (1) the bubble model describes correctly the behavior of the positronium atom in aliphatic compounds and their derivatives, and (2) the positronium atom apparently annihilates only on the valence electrons of the molecules. (A.G.W.)

Collision Phenomena

2807 (CEA-CONF−1798) KINETIC ENERGIES OF COLLISION-INDUCED DISSOCIATIONS OF 40 TO 140 KeV CH_n^+ IONS. Guidini, J.; Julienne, A.; Roussel, M.; Valckx, F. P. G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1971]. 2p. (CONF-710702−3). Dep. NTIS (U. S. Sales Only).

From seventh international conference on the physics of electronic and atomic collisions; Amsterdam, Netherlands (26 Jul 1971).

A study of kinetic energies of products of dissociation of CH_n^+ ions induced by collisions with N_2 is summarized briefly. Energy spectra of various secondaries are shown in diagrams. (A.G.W.)

2808 (CEA-CONF−1799) COLLISIONAL REACTIONS OF 40 TO 140 keV CH_n^+ IONS ON DIFFERENT GASES. Guidini, J.; Roussel, M.; Valckx, F. P. G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1971]. 2p. (CONF-710702−4). Dep. NTIS (U. S. Sales Only).

From seventh international conference on the physics of electronic and atomic collisions; Amsterdam, Netherlands (26 Jul 1971).

A program of cross-section measurements is summarized briefly. The primary ions used were CH_n^+ with n = 0 to 4 and the gas targets were H_2, D_2, N_2, He, Ne, and Ar. Cross sections at 100 keV for different reactions and different gases are tabulated. (A.G.W.)

2809 (ORO-1316-98) EXTRA-NUCLEAR PHYSICS. Progress Report. Walters, G. K. (Rice Univ., Houston, Tex.). [31 Mar 1970]. Contract AT(40-1)-1316. 15p. Dep. NTIS.

Progress in experimental research on the following is summarized: sources of polarized electrons, energetic excitation in electron-bombarded liquid helium, uv lasers, and metastable–neutral collision processes. Theoretical research is summarized on excited atomic states and spectral line broadening in liquid He, binary He*–He interaction potentials, collisions between He atoms and ions in various energy states, excitation of C^+ in collisions with H atoms, Penning ionization of H by He atoms, and resonant electronic excitation of molecules by electron impact. No data are given. A list of 14 papers in preparation or submitted for publication is included. (A.G.W.)

2810 THEORY OF ATOMIC PHOTON–PARTICLE COINCIDENCE MEASUREMENTS. Macek, Joseph; Jaecks, D. H. (Univ. of Nebraska, Lincoln). Phys. Rev., A; 4: No. 6, 2288-2300(Dec 1971).

The theory of measurements in which photons are detected in delayed coincidence with a scattered particle is developed in a form specifically applicable to atomic collisions. Equations are obtained, which relate the measured coincidence rate to excitation amplitudes. These equations incorporate the polarization of the radiation, the fine and hyperfine structure of the atomic levels, the coherence of the radiation, and the time dependence of the radiation intensity. A semiclassical model for certain transitions is introduced to illustrate new features of coincidence measurements. The Ly-α transitions in hydrogen and $^1P \rightarrow {}^1S$ transitions in He are treated in detail to illustrate the general theory. (auth)

2811 COMPARISON OF THE LANDAU–ZENER THEORY WITH MEASUREMENTS OF ELECTRON CAPTURE IN B^{3+} + He COLLISIONS. Zwally, H. Jay.; Cable, P. G. (Univ. of Maryland, College Park). Phys. Rev., A; 4: No. 6, 2301-4(Dec 1971).

An experimental total cross section for single-electron capture by helium-like B^{3+} from He was measured at relative velocities between 0.7 and 7.4×10^7 cm/sec (300-eV to 31.5-keV B^{3+} laboratory energy) and was compared with a cross section calculated via the Landau–Zener theory. In the velocity range considered, the dominant crossing of the $(B + He)^{3+}$ system is between s states and the often-neglected conditions for applicability of the theory are met. The velocity positions of the cross-section maxima are in agreement, but the experimental magnitude at maximum is greater by a factor of 2. (auth)

2812 SCATTERING WITH CHARGE EXCHANGE TO THE STATE H(2p) FOR THE SYSTEMS H^+ + He AND H^+ + Ar. McKnight, R. H.; Jaecks, D. H. (Univ. of Nebraska, Lincoln). Phys. Rev., A; 4: No. 6, 2281-8(Dec 1971).

Studies have been made of differential scattering with charge exchange to the 2p state of hydrogen for the systems $H^+ + Ar$ and $H^+ + He$. Fast hydrogen atoms in the state H(2p) resulting from the collision process were detected by making coincidence measurements between the Ly-α photon emitted in the decay of the 2p state and the resultant fast neutral particle. The probability of transfer to the state H(2p), P_{2p}, is presented for $H^+ + Ar$ for the condition $\Theta T = 20$ keV deg, where Θ is the scattering angle and T the incident-ion kinetic energy, which represents an impact parameter of 0.53 a.u. For the $H^+ + He$ system a comparison between experimental results for P_{2p} and the many-state calculation of Sin Fai Lam shows the theory to overestimate P_{2p} by an order of magnitude for $\Theta T = 20$ keV deg as well as for measurements where the impact parameter varied from 0.05 to 0.25 a.u. (auth)

2813 CHARGE TRANSFER TO THE 2s STATE OF HYDROGEN FROM CLOSE COLLISIONS OF H^+ WITH He AND Ar. Crandall, D. H.; Jaecks, D. H. (Univ. of Nebraska, Lincoln). Phys. Rev., A; 4: No. 6, 2271-80(Dec 1971).

Measurements of the electron-capture probability for close encounters in the reactions $H^+ + He \rightarrow H(2s) + He^+$ and $H^+ + Ar \rightarrow H(2s) + Ar^+$ are reported. The incident proton energies employed range from 3 to 20 keV. Measurements were made for particular impact parameters by selecting particular angles of scatter between 1 and 5°. The data show little angular dependence but exhibit structure as a function of collision time. For $H^+ + He \rightarrow H(2s) + He^+$ this structure is similar to that observed previously by Everhart and co-workers for capture into all states of hydrogen for the reaction $H^+ + He \rightarrow H + He^+$, which is dominated by transfer to the 1s state of hydrogen. The present data are not in agreement with available coupled-state calculations for this process. (auth)

2814 QUANTUM-MECHANICAL CALCULATION OF CROSS SECTIONS FOR INELASTIC ATOM–ATOM COLLISIONS. II. MODEL CALCULATION UNDER VARIOUS COUPLING CONDITIONS. Cohen, J. S.; Evans, S. A.; Lane, Neal F. (Rice Univ., Houston, Tex.). Phys. Rev., A; 4: No. 6, 2248-53(Dec 1971).

Quantum-mechanical close-coupling calculations of elastic and inelastic cross sections were carried out for a two-level model problem with variable diabatic coupling. The purpose of these calculations is to illustrate explicitly how the behavior of the inelastic cross section changes as the diabatic coupling is reduced, eventually approaching the semiclassical Stueckelberg–Landau–Zener result. (auth)

2815 QUANTUM-MECHANICAL CALCULATION OF CROSS SECTIONS FOR INELASTIC ATOM–ATOM COLLISIONS. I. INELASTIC $2^3S \rightarrow 2^3P$ COLLISIONS BETWEEN METASTABLE AND GROUND-STATE HELIUM ATOMS. Evans, S. A.; Cohen, J. S.; Lane, Neal F. (Rice Univ., Houston, Tex.). Phys. Rev., A; 4: No. 6, 2235-48(Dec 1971).

A quantum-mechanical two-state close-coupling calculation of the inelastic cross section for the $2^3S \rightarrow 2^3P$ excitation was carried out for collisions between 2^3S metastable and ground-state helium atoms in the center-of-mass (cm) energy range 5 to 500

eV. The calculations were carried out in both the diabatic and adiabatic representations using two single-configuration valence-bond molecular wave functions and the corresponding adiabatic linear combinations, respectively. Both representations, as expected, gave identical results. In the diabatic representation, the coupling matrix element was found to be extremely large, resulting in a strong avoided crossing of the corresponding adiabatic potential curves and very small inelastic cross sections for energies $E \lesssim 100$ eV (cm) but increasing to a value of about 4×10^{-16} cm^2 at 500 eV (cm). The semiclassical Stueckelberg–Landau–Zener approximation was found to be very poor at all energies considered. The JWKB distorted-wave approximation was found to be fairly good at energies $E \gtrsim 400$ eV (cm). (auth)

2816 HYDROGEN EXCITATION IN H-α COLLISIONS BY SECOND BORN APPROXIMATION. Chowdhury, Jayasri; Bhattacharya, D. M. (Indian Association for the Cultivation of Science, Calcutta). Indian J. Phys.; 44: No. 1, 63-5(Jan 1970).

Bates (Proc. Phys. Soc., A73: 227(1959)) investigated the alpha-particle excitation of atomic hydrogen. Using the impact-parameter treatment, he showed that the introduction of allowance for distortion leads to much smaller cross sections than those obtained by the first Born approximation at low and moderate energies. In this note the same problem is investigated in the second Born approximation, and the findings are compared with the previous results. (auth)

2817 VARIATIONAL APPROACH TO THE FESHBACH EQUATIONS FOR SCATTERING. Chung, Kwong, T. (North Carolina State Univ., Raleigh); Chen, J. C. Y. Phys. Rev. Lett.; 27: No. 17, 1112-14(25 Oct 1971).

A variational method is constructed for the Feshbach equations for scattering. An example is carried out on the S-wave electron–hydrogen system. It is shown that fast convergence of the phase shift can be obtained throughout the energy range of interest including the resonance region. No anomalous singularities have been encountered. (auth)

2818 UTILITY OF GAUSSIAN-TYPE ORBITALS IN MOLECULAR COLLISIONS: ELECTRONIC EXCITATION OF THE FIRST POSITIVE SYSTEM OF THE NITROGEN MOLECULE. Chung, S.; Lin, Chun C. (Univ. of Wisconsin, Madison). Appl. Opt.; 10: No. 8, 1790-4(Aug 1971).

The use of gaussian-type orbitals (GTO) as basis sets of electronic wave functions of molecules for calculating electron-collision excitation cross sections is discussed. A test calculation of the electron excitation cross section of the 2p state of atomic hydrogen at 60 to 1000 eV in which the hydrogenic wave functions were expressed as linear combinations of GTO indicates that an expansion of the 1s wave function by six GTO's and the 2p by four GTO's gives quite accurate results. Methods for evaluating the multicenter integrals that appear in the expressions for electron-excitation cross sections (by the Born-type approximation) of diatomic molecules are described. Cross sections of direct electron excitation of the $B^3\Pi_g$ state (the first positive bands) of the N_2 molecule are calculated by this scheme, and the results are in good agreement with experiments. (auth)

2819 ELASTIC SCATTERING OF ELECTRONS BY HELIUM ATOMS AT LOW ENERGY. Roy, Amulya Chandra (Univ. of Kalyani, India). Indian J. Pure Appl. Phys.; 6: No. 9, 461-4 (Sep 1968).

The variational methods of Hulthen and Kohn were applied to the elastic scattering of slow electrons by helium atoms, the effect of both polarization and exchange being taken into account. The phenomenon of polarization in exchange was, however, ignored in calculating the zero-order phase shift. An endeavor was made to study this collision at 0.04 eV by approximating the polarization potential proposed by H. Reeh [Z. Naturforsch., 15a: 377 (1960)]. It was found that the computed scattering phase shifts and cross sections are in fair agreement with the experimental results. (auth)

2820 L_{II} AND L_{III} IONIZATION CROSS SECTIONS IN GOLD AT VERY LOW ENERGIES. Salem, S. I.; Moreland, L. D. (California State Coll., Long Beach). Phys. Lett.; 37A: No. 2, 161-2(8 Nov 1971).

The L_{II} and L_{III} ionization cross sections in gold were measured for an incident ionizing electron beam of energy E_{inc}, in the range $I < E_{inc} < 4I$. The results are compared to those predicted on the basis of classical theory as well as Born-approximation calculations. (auth)

2821 ASYMMETRIC AUTOIONIZATION LINES IN ELECTRON SPECTRA OF HELIUM PRODUCED BY 300-keV PROTONS. Stolterfoht, N. (Hahn-Meitner-Institut fuer Kernforschung GmbH, Berlin). Phys. Lett.; 37A: No. 2, 117-18(8 Nov 1971).

Absolute cross sections for the ejection of electrons from autoionizing states by proton impact were measured. Fano-line profiles were observed in the energy spectra for several angles of electron emission up to 150°. (auth)

2822 AUGER ELECTRONS PRODUCED BY ION BOMBARDMENT. Viel, L.; Benazeth, C.; Fagot, B.; Louchet, F.; Colombie, N. (Univ., Toulouse). Compt. Rend., Ser. B; 273: No. 1, 30-2(5 Jul 1971). (In French).

Auger electrons characteristic of the sample are observed in the energy spectrum of the secondary electrons produced by ion bombardment. They correspond to the $L_{23}VV$ transition of Mg, Al, and Si, and the $M_{23}VV$ transition of Ti, Cr, Fe, and Cu. Two or three typical losses due to surface-plasmon excitation by the Auger electrons are observed near the Auger peak. (France)

2823 ASYMPTOTIC FORM OF THE WAVEFUNCTION FOR NEUTRAL PARTICLE–HYDROGEN ATOM SCATTERING. Doolen, G. (Texas A and M Univ., College Station); Nuttall, J. J. Math. Phys. (N. Y.); 12: No. 10, 2198-2203(Oct 1971).

The asymptotic form of the wave function for the scattering of a neutral particle on a hydrogen-atom bound state is discussed, with particular reference to the case where the two charged particles may be close together in the asymptotic region. (auth)

2824 IONIZATION–EXCITATION PROCESSES IN ZINC, CADMIUM, AND MERCURY. Hyman, Howard A. (Yale Univ., New Haven). J Chem. Phys.; 55: No. 8, 3642-7(15 Oct 1971).

Cross sections for ionization–excitation by photon and high-energy electron impact were calculated for several states of zinc, cadmium, and mercury. Such processes are of interest both theoretically, in that they are an extremely sensitive probe into electron correlation effects in atoms, as well as practically, in that they may play an important role in the population of many upper ion laser levels. A model for the ionization–excitation process was developed, which takes full account of correlation in the initial state but includes only the screening part of the final-state interaction. (auth)

2825 MOLECULAR COLLISIONS. XV. CLASSICAL LIMIT OF THE GENERALIZED PHASE SHIFT TREATMENT OF ROTATIONAL EXCITATION: ATOM–RIGID-ROTOR. Pattengill, M. D.; Curtiss, C. F.; Bernstein, R. B. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 55: No. 8, 3682-93(15 Oct 1971).

The generalized phase shift (GPS) approach to the problem of rotationally inelastic molecular collisions is extended from the level of the first-order (semiclassical) approximation of Paper XIV [J. Chem. Phys., 54: 2197(1971)] to the essentially infinite-order level, but specialized to the full classical limit. The limitations and assumptions are that (i) the de Boer reduced wavelength parameter be small (i.e., $\Lambda^* \ll 1$), (ii) the relative translational motion takes place under the influence of the orientation-averaged (spherical) part of the anisotropic interaction potential (i.e., curved but planar trajectories), and (iii) the rotational energy, E_{rot}, may be well approximated by its classical expression (i.e., rotational quantum numbers $\gg 1$). The procedure is applied numerically to a model problem involving an anisotropic L-J (12,6) potential (as in XIV), taking advantage of the previously computed generalized action integrals. The program yields directly an arbitrarily chosen specified number of moments of the inelasticity probability density function $P(\Delta E_{rot})$ at various impact parameters b. Inversion of the set of moments leads to $P(\Delta_{rot})$. For the examples chosen, the lowest eight moments suffice to obtain practical accuracy of convergence on the inversion. For large b, i.e., in the weak-coupling regime, the first moment vanishes and the second moment (which can be well-approximated using the first-order results of XIV) dominates, governing the breadth of the inelasticity density function. (auth)

2826 FORMATION OF MAGNESIUM IONS BY CHARGE TRANSFER. Rutherford, J. A.; Mathis, R. F.; Turner, B. R.; Vroom, D. A. (Gulf Radiation Tech., San Diego, Calif.). J. Chem. Phys.; 55: No. 8, 3785-93(15 Oct 1971)

The charge-transfer cross sections for several ions in collision with atoms of magnesium to form Mg^+ were measured in the energy range 1–500 eV. The ions O^+, N^+, N_2^+, NO^+, O_2^+, H_2O^+, H_3O^+, N_2O^+, and Mg^+ were used. The results obtained are analyzed by considering the possibility of resonant or near-resonant processes being responsible for the large cross sections obtained for most processes. When the possibility of resonance-type mechanisms does not exist, the cross sections are found to be considerably

smaller. The effect of metastable states present in the primary ion beam on the charge-transfer cross section is examined. Extrapolation of the measured cross sections to thermal energies was also performed. (auth)

2827 EMISSION OF THE WERNER BAND SYSTEM AND LYMAN-α RADIATION FOR 0.05 TO 6-keV ELECTRONS IN H_2. De Heer, F. J.; Carriere, J. D. (FOM-Instituut voor Atoom-en Molecuulfysica, Amsterdam). J. Chem. Phys.; 55: No. 8, 3829-35(15 Oct 1971).

Relative cross sections as a function of impact energy were measured for the emission of Werner bands $C(2p\pi\ ^1\Pi_u) - (1s\sigma\ ^1\Sigma_g^+)$ and Lyman-α radiation for 0.05- to 6-keV electrons on molecular hydrogen. The cross sections for the Werner bands are normalized on theoretical Born or Bethe cross sections, evaluated by means of the theoretical generalized oscillator strengths of Miller and Krauss and the theoretical optical oscillator strengths and transition probabilities of Allison and Dalgarno. By comparing the cross sections thus obtained and the relative intensity measurements, the sensitivity of our optical detection system can be determined between about 1030 and 1250 Å. It is then also possible to bring the relative cross sections for Lyman-α radiation at 1215.7-Å on an absolute scale. The latter cross sections appear to be 1.31 times smaller than those reported by Vroom and De Heer, which data were normalized on the so-called countable ultraviolet cross sections of Fite and Brackmann. In the latter normalization, the contribution of the Werner bands to the countable ultraviolet cross sections has been neglected. (auth)

2828 APPROXIMATE DIFFERENTIAL CROSS SECTIONS AT LARGE SCATTERING ANGLES FOR SIMPLE REPULSIVE POTENTIALS. Gislason, E. A. (Univ. of California, Berkeley). J. Chem. Phys.; 55: No. 8, 3929-36(15 Oct 1971).

The classical deflection angle θ and the classical differential cross section $I(\theta)$ are examined in the region near $\theta = 180°$ for three simple repulsive potentials: the repulsive power potential; the exponential repulsive potential; and the screened Coulomb potential. An expansion for θ valid at small impact parameters is carried through second order and compared with exact calculations of θ and $I(\theta)$. In most cases, the expansion is quite accurate in the region from $\theta = 180°$ to $\theta = 80°$. Numerical formulas are given for evaluating the first two coefficients in the expansion. Interpretation of experimental cross sections using these results is discussed. (auth)

2829 LARGE-ANGLE ELASTIC SCATTERING OF Ar^+ BY He. Chiang, M. H.; Gislason, E. A.; Mahan, B. H.; Tsao, C. W.; Werner, A. S. (Univ. of California, Berkeley). J. Chem. Phys.; 55: No. 8, 3937-43(15 Oct 1971).

Measurement of accurate differential cross sections for systems including a heavy projectile and a light target are shown to be practical, provided measurements are restricted to large center-of-mass scattering angles θ. As an example, cross sections for the system Ar^+–He were measured from $\theta = 60$ to 180° in the energy range 2.7 to 9.1 eV. Using two-parameter repulsive potentials the results are inverted to yield a potential that reproduces the scattering at all energies. Dramatic evidence is given that potentials of the form $V(r) = K/r^s$ are unsatisfactory for fitting the intermolecular potential in the region of 1 to 10 eV. The potential derived from these experiments is an average of two molecular potentials, since both the $X\ ^2\Sigma$ and $A\ ^2\pi$ states of Ar^+–He correlate to ground-state atoms. Comparisons are made with theoretical estimates of the two molecular potentials and with the Ar–He^+ and Ar–He potentials. (auth)

2830 MEASUREMENTS OF SECONDARY-ELECTRON SPECTRA PRODUCED BY ELECTRON-IMPACT IONIZATION OF A NUMBER OF SIMPLE GASES. Opal, C. B.; Peterson, W. K.; Beaty, E. C. (Univ. of Colorado, Boulder). J. Chem. Phys.; 55: No. 8, 4100-6(15 Oct 1971).

The energy distribution and angular dependence of secondary electrons generated by the impact of 100- to 2000-eV electrons on He, N_2, and O_2 and by the impact of 500-eV electrons on Ne, Ar, Kr, Xe, H_2, NO, CO, H_2O, NH_3, CH_4, C_2H_2, and CO_2 were measured over the 4- to 200-eV range. The measurements were made in a crossed-beam apparatus with the use of a fixed hemispherical electrostatic analyzer and a rotatable electron gun. The observed spectra were integrated over angle to obtain relative cross sections for secondary-electron production. It was found that the shapes of the spectra of all the gases (except Ar, Kr, and Xe, which contain intense electron emission features in this energy range) were smooth and qualitatively similar, approaching a constant cross section at low secondary energies, and falling off at high secondary energies slightly faster than E_s^{-2}, where E_s was the energy of the secondary. The shape of the spectrum was found to be nearly independent of primary energy in He, O_2, and N_2. (auth)

2831 COMMENT ON ABSOLUTE DIFFERENTIAL CROSS SECTIONS OF ELASTICALLY SCATTERED ELECTRONS. II. A POLARIZATION SCATTERING POTENTIAL FOR Hg AT 500, 400, AND 300 eV. Bonham, R. A. (Univ. of Hokkaido, Sapporo. Indiana Univ., Bloomington); Fink, M. J. Chem. Phys.; 55: No. 8, 4116-8(15 Oct 1971).

The interpretation of Bromberg's measurements of absolute experimental elastic scattering cross sections for Hg with 300-, 400-, and 500-eV incident electrons is discussed. Both multichannel Born series and a partial-wave analysis utilizing a static polarization potential are employed to discuss the results. The desirability of comparing the accurate partial-wave differential cross section for the static potential with the absolute experimental cross section is pointed out. In addition it is suggested that the observed exponential behavior of the experimental cross section is the result of multiple scattering of the incident electron wave. (auth)

2832 CONCERNING THE POSSIBILITY OF COMPETITION IN IONIZATION OF MOLECULES BY ELECTRON IMPACT. Rapp, Donald (Univ. of Texas, Dallas). J. Chem. Phys.; 55: No. 8, 4154-6(15 Oct 1971).

A theory of competition proposed by Lifshitz and Long (J. Chem. Phys., 41: 2468(1953)) and extended by Morrison and Traeger (J. Chem. Phys., 53: 4053(1970)) is discussed. It is suggested that a self-consistent interpretation of available data is possible without invoking the notion of competition. In a reply by C. Lifshitz and a note added after the reply, the effects of autoionization and a comparison with photoionization data are also considered. (A.G.W.)

2833 ELECTRON CORRELATION STUDIES. I. ELECTRONIC STRUCTURE OF NEON. II. ELECTRON–HYDROGEN SCATTERING. Viers, Jimmy Wayne. Stanford, Calif.; Stanford Univ. (1971). 95p. University Microfilms Order No. 71-23,567.

Thesis.

In Part I a variationally determined set of atomic orbitals is used to examine the validity of pair-correlation approximations for the Ne atom. Summing the usual pair correlation energies ('regular pairs') yields 100.5% of the correlation energy. By summing symmetry-adapted pair correlation energies, 90.2% of the correlation energy is obtained. The complete second-order wave function, which includes the Hartree–Fock configurations plus all singly and doubly excited configurations, produces 88.6% of the correlation energy. Using estimates of errors in the correlation energy caused by truncation of the basis set and neglect of higher than double excitations of electrons, it is projected that the sum of the 'regular pairs' overestimates the correlation energy by at least 10%, whereas the sum of the symmetry-adapted pairs agrees with the experimental correlation energy to within about 2%. In Part II variational methods using various analytic expansions for calculating scattering wave functions are analyzed for the elastic scattering of electrons from hydrogen. Particular attention was given to the variational method involving a norm-minimization criterion developed recently by Harris and Michels. The older methods of Hulthen, Kohn, and Hulthen–Rubinow were reformulated so that these three older methods could be compared with the newer minimum-norm method. Calculations were carried out in several approximations including static + exchange, 1s + 2s strong-coupling, 1s + 2s + 2p algebraic close-coupling, and an unrestricted configuration interaction for the short-range expansion. In all the cases examined, the minimum-norm criterion yields the optimum analytic expansion. In addition, the criterion suggested by Nesbet for choosing between the Kohn or Hulthen–Rubinow methods is automatically satisfied; and the minimum-norm phase shifts are invariably closer to the best values calculated from either of these earlier approximations when the results from these methods differ by any substantial amount. (Diss. Abstr. Int., B)

2834 FINAL STATES IN DISSOCIATIVE EXCITATION OF MOLECULAR HYDROGEN. Misakian, Martin. Ann Arbor, Mich.; Univ. of Michigan (1971). 80p. University Microfilms Order No. 71-23,830.

Thesis.

Dissociative excitation of molecular hydrogen can proceed via the process $H_2 + e \rightarrow H(2S) + H + e$ and yield metastable H(2S) atoms that have kinetic energies near 0.3 eV (slow) or near 4 eV (fast). The dissociation process was studied using a pulsed electron gun with an energy resolution of ±0.3 eV and using a metastable atom detector capable of viewing H(2S) atoms with an angular resolution of one degree over a range of 60 to 120 degrees with respect to the electron-beam direction. The measurement of the angular intensity distribution gives information about the final states involved in the dissociation process. The electron energy threshold for production of the least energetic of the slow meta-

stable atoms is 14.6 ± 0.3 eV. The angular distribution of these atoms suggests that they arise mainly from dissociation out of Σ_u^+ states and predissociation out of π_u^+ states. The form of the excitation function combined with the knowledge of certain mixing perturbations indicates that the parent states are primarily the $B'^1\Sigma_u^+$, $e^3\Sigma_u^+$, $D^1\pi_u^+$, and $d^3\pi_u^+$ levels. The electron energy threshold for production of the least energetic of the fast H(2S) atoms is near 29 eV. The angular distribution data would indicate that these atoms arise from a π_u state; the form of the excitation function indicates that the parent state has a multiplicity of one. The change in energy distribution of the fast H(2S) atoms, measured as a function of electron gun voltage, supports the view that the $^1\pi_u$ state is a previously unreported double excited state that has an asymptotic energy of 24.9 eV. (Diss. Abstr. Int., B)

Atomic Theory

Refer also to abstracts 2228 and 3430.

2835 DIFFERENTIAL GEOMETRY OF ATOMIC STRUCTURE AND THE BINDING ENERGY OF ATOMS. Ramanna, R.; Jyothi, S. (Bhabha Atomic Research Centre, Bombay). Int. J. Theor. Phys.; 4: No. 5, 339-59(Sep 1971).

The geometric theory of partial differential equations due to E. Cartan is applied to atomic systems in order to solve the many-body problems and to obtain the binding energies of electrons in an atom. The procedure consists in defining a Schrödinger equation over an Euclidean patch that overlaps with other Euclidean patches in a specified way to form a manifold. If the energy of the system has to be a minimum, it is shown using the Dirichlet principle that the coordinate systems are related by the Cauchy–Riemann relations. The invariance of the Schrödinger equations in the overlapping region leads to a nonlinear second-order equation, which is invariant to automorphic transformations and whose solutions are doubly periodic functions. There are only two possible single-valued solutions to this nonlinear partial differential equation and these correspond to lattices of points in the complex space, which are (a) corners of an array of equilateral triangles, and (b) corners of an array of isosceles right-angled triangles. It is shown that the second solution gives binding energies of atoms in agreement of about 3% for the few experimental points available and also in good agreement with the binding energies of atoms obtained by the perturbation theory. It is also shown that this lattice under certain approximations is equivalent to a pure Coulomb law and the Bohr orbits of the hydrogen atom are correctly predicted. In obtaining the binding energies of atoms, no free parameters are required in the theory, except for the value of the binding energy of the ^{4}He atom, as the theory is developed only for spinless systems. All other constants turn out to be fundamental constants. (auth) (UK)

2836 SCATTERING BY A VAN DER WAALS FORCE IN THE BORN APPROXIMATION. Ganas, P. S. (California State Coll., Los Angeles). Phys. Rev., A; 4: No. 6, 2224-6(Dec 1971).

By using the Born approximation an analytic formula is derived for the phase shifts δ_l for scattering by a van der Waals r^{-6} potential. It is found that at low energies $\tan\delta_l$ varies as k^{2l+1} for s and p waves and $\tan\delta_l$ varies as k^4 for all the higher partial waves. Comparison is made with available results from standard effective-range theory. (auth)

2837 OFF-SHELL AND ON-SHELL UNITARITY RELATIONS IN TWO-BODY COULOMB SCATTERING. Chen, Augustine C.; Chen, Joseph C. Y. (Univ. of California, San Diego, La Jolla). Phys. Rev., A; 4: No. 6, 2226-8(Dec 1971).

It is demonstrated that the Coulomb T matrix $T(\vec{p}_2, \vec{p}_1; E \pm i\eta)$ satisfies a modified off-shell unitarity relation with a phase factor that depends upon the region from which the on-shell limit is approached. However, the on-shell Coulomb unitarity relation is not well defined. The discontinuities across the on-shell Coulomb cut in the p_2 and p_1 planes are evaluated. (auth)

2838 RE-EXAMINATION OF SCATTERING BY A PAIR OF FIXED DIPOLAR CHARGES. Garrett, W. R. (Oak Ridge National Lab., Tenn.). Phys. Rev., A; 4: No. 6, 2229-35(Dec 1971).

Upon careful examination of charged-particle scattering by a finite stationary dipolar system, it is found that the long-range nature of the dipole potential leads to divergence of the total scattering cross section. Thus, contrary to the results of Takanagi and Itikawa, the total cross sections for the finite dipole diverge in a manner similar to that found earlier by Mittleman and von Holdt for the point dipolar field. (auth)

2839 APPROXIMATE SOLUTION TO THE SUPERRADIANCE MASTER EQUATIONS. Degiorgio, Vittorio (Centro Informazioni Studi Esperienze, Milan); Ghielmetti, Francesco. Phys. Rev., A; 4: No. 6, 2415-17(Dec 1971).

An approximate solution is given to the master equation describing the cooperative spontaneous emission from a large number of excited two-level atoms. The solution allows an easy analytical computation of the statistical properties of the radiated optical field. Comparison with previously reported computer results shows a satisfactory agreement. Furthermore, a formal justification is provided to a recent heuristic model of superradiant pulses. (auth)

Cosmic Radiation

Refer also to abstracts 2759, 3186, 3190, 3227, and 3275.

2840 (N-71-28308) COSMIC-RAY PROTON AND HELIUM MEASUREMENTS OVER HALF A SOLAR CYCLE 1965-1969. Rygg, Thomas A. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Jun 1970. 111p. (NASA-CR-119013). NTIS. Thesis.

Cosmic-ray proton and helium differential energy spectra covering the energy range 100 to 260 MeV/nucleon were obtained in balloon flights made each summer 1965 to 1969. The flights cover nearly the full extent of the solar cycle from solar minimum to solar maximum. The spectral contribution of atmospheric secondary protons is calculated, including the effect of solar modulation, and agrees with observations made with various detectors. The calculated secondary proton intensity varies 47% over the solar cycle. Integral proton and helium fluxes above 260 MeV/nucleon confirm the general rigidity dependence of solar modulation as predicted by most diffusion–convection models. However, the spectral results, including the proton flux from 260 to 720 MeV obtained by ionization measurements, show that simple diffusion–convection theory does not explain the results below a few hundred MeV/nucleon. A model that assumes adiabatic deceleration of high-energy cosmic rays is proposed to explain the low-energy proton and helium results. (auth) (STAR)

2841 CROSS SECTION FOR ^{10}Be PRODUCTION BY HIGH ENERGY FRAGMENTATION OF OXYGEN. Raisbeck, G. M.; Yiou, F. (CNRS, Orsay, France). Nature (London) Phys. Sci.; 233: No. 39, 73-4(27 Sep 1971).

It is stated that a knowledge of the spallation cross section for the production of ^{10}Be from oxygen is important for several astrophysical problems, particularly in the dating of meteorites and cosmic rays. Several years ago, when the first direct measurements of this cross section were made, the values obtained were found to be much lower than had been previously estimated. Those working in cosmic-ray physics have generally accepted the new values, but those doing meteorite studies have tended to retain the older values; an argument for the latter attitude was given by Goel (Nature, 223: 1263(1969)), based on indirect evidence obtained from comparative analysis of ^{10}Be and ^{3}H concentrations in stone meteorites. An error in Goel's analysis is, however, pointed out. Among other things it is not clear that the assumption that oxygen is the main target for the production of ^{10}Be in stone meteorites is correct; a large fraction of the ^{10}Be may arise from targets such as Si, Mg, and Fe. Also, meteorite activation is never a reliable measure of a simple well-defined reaction, but can involve important contributions from various secondary processes. It is considered necessary to modify all the astrophysical conclusions that are affected by the newer cross sections. (UK)

2842 BALLOON MEASUREMENTS OF COSMIC-RAY PROTONS AND HELIUM OVER HALF A SOLAR CYCLE 1961–1969. Rygg, Thomas A.; Earl, James A. (Univ. of Maryland, College Park). J. Geophys. Res.; 76: No. 31, 7445-69(1 Nov 1971).

Differential energy spectra for protons and helium covering the energy range 100 to 260 MeV/nucleon were obtained from balloon flights made each summer (1965–1969) at Churchill, Manitoba, with the aid of a Geiger-tube hodoscope operated in conjunction with two scintillation elements used to measure (dE/dx) and E. Supplementary data from balloon flights at Minneapolis, Minnesota, and Sioux Falls, South Dakota, and from calibration exposures to protons and electrons were used to define backgrounds and to verify the predicted detector response. The observed proton spectra are characterized over a wide range of energy (30 to 300 MeV) by a simple relationship between cosmic-ray intensity J and kinetic energy T: $J = AT$. The helium spectra also follow this law at solar maximum but rise less steeply near solar minimum. This characteristic behavior can be interpreted in terms of a simple model in which convection is balanced by adiabatic deceleration. (auth)

2843 ENERGY DEPENDENCE OF THE COSMIC-RAY NEUTRON LEAKAGE FLUX IN THE RANGE 0.01 TO 10 MeV. Jenkins, R. W.; Ifedili, S. O.; Lockwood, J. A.; Razdan, H. (Univ. of New Hampshire, Durham). J. Geophys. Res.; 76: No. 31, 7470-8 (1 Nov 1971).

The cosmic-ray neutron leakage flux and energy spectrum in the range 1 to 10 MeV were measured by a neutron detector on the Ogo 6 satellite from June 7 to September 30, 1969. The same detector simultaneously measured the total leakage flux, having 75% of its response to the leakage flux in the interval 1 keV to 1 MeV. For a neutron energy spectrum of the form $AE^{-\gamma}$ in the range 1 to 10 MeV, the upper limit to γ for polar regions ($P_c \geq$ 0.3 GV) was found to be 1.0 and for the equatorial regions ($P_c \leq$ 12 GV) was 1.2. For the polar regions, the lower limit to γ was found to be 0.8. This energy spectrum at 1 to 10 MeV is slightly flatter than L. L. Newkirk predicted. The neutron fluxes at 1 to 10 MeV were 0.28 ± 0.03 and 0.035 ± 0.003 cm^{-2} sec^{-1} for $P_c \geq$ 0.3 and $P \leq$ 12 GV, respectively. The ratios of the neutron flux at 1 to 10 MeV to the total neutron flux were 0.54 ± 0.07 for $P_c \leq$ 0.3 GV and 0.50 ± 0.006 for $P_c >$ 12 GV. (auth)

2844 COSMIC-RAY VARIATIONS AND THE INTERPLANETARY SECTOR STRUCTURES. Yoshida, S. (Univ. of Alaska, College); Ogita, N.; Akasofu, S.-I. J. Geophys. Res.; 76: No. 31, 7801-3(1 Nov 1971).

A clear north–south asymmetry of cosmic-ray intensity that depends on the sign of the interplanetary-sector magnetic fields was reported from analysis of 15 passages of the sector structures that occurred between Dec. 23, 1967 and June 28, 1968. The method of Yoshida, et al., 1971 (NSA 25: 11745), was used for the spherical harmonic analysis of cosmic-ray intensity variations as a function of asymptotic latitude, longitude, and universal time. Results shown in graphs verify the asymmetry of the north–south intensity during passages (±36 hours) of the interplanetary sector boundaries and during passages (±7 days) of the interplanetary sector structures. The time of the crossing of the boundaries was taken to be zero. (J.C.W.)

2845 CORRELATION OF GALACTIC COSMIC-RAY INTENSITY WITH λ5303 CORONAL INTENSITY. Pathak, P. N. (Physical Research Lab., Navrangpura, India). J. Geophys. Res.; 76: No. 31, 7804-7(1 Nov 1971).

Data taken in the period from 1966 to 1969, which is the rising part of the solar-activity cycle, were used to confirm earlier results that the long-term modulation of galactic cosmic-ray intensity is linearly related to λ5303 coronal intensity close to the solar equator (±5 or ±10°), whereas hysteresis is seen only when coronal intensity at higher heliolatitudes is considered. The analysis shows that the diffusion–convection process producing the long-term modulation of galactic cosmic rays measured on the Earth is largely governed by interplanetary conditions along the plane of the ecliptic and the solar activity close to the solar equator. It is concluded that the cosmic-ray diffusion in the region relevant to the modulation is largely anisotropic and occurs along the spiral magnetic-field lines. The absence of hysteresis at low heliolatitudes suggests that the cosmic-ray modulation over a solar cycle occurs within a region of about 3 to 5 AU from the Sun. (J.C.W.)

2846 MEASUREMENTS OF THE CHARGE AND ISOTOPE COMPOSITION OF COSMIC-RAY Li, Be, AND B NUCLEI. Webber, W. R.; Damle, S. V.; Kish, J. M. (Univ. of New Hampshire, Durham). Astrophys. Lett.; 9: No. 3, 125-9(Oct 1971).

Cosmic-ray Li, Be, and B nuclei were measured using two new detectors, a large-area dE/dx-E-range telescope, and a dE/dx-Cherenkov-range telescope. The L/M ratio was found to be 0.23 ± 0.01, essentially constant with energy between 100 MeV/n to > 2 BeV/n. The observed ratio Be/(Li + B) was in generally good agreement with that predicted on the basis that ^{10}Be has decayed. Furthermore, the observed Be^7/Be^{7+9+10} ratio of 0.76 ± 0.08 was also consistent with this hypothesis. The average lifetime of the cosmic rays producing Be must therefore be $\gtrsim 1 \times 10^7$ yr. This value taken together with the value of $X_0 \sim 5$ g/cm^2 obtained from the L/M ratio leads to an average matter density of $\lesssim 0.2$ g/cm^2 along the interstellar trajectories of the cosmic-ray particles producing L nuclei. (auth)

Direct Energy Conversion

Refer also to abstracts 3769, 3853, 4004, and 4006.

2847 (N-71-32279) EVALUATION OF CONVERTERS FUELED WITH URANIUM NITRIDE. Shimada, K.; Cassell, P. L. (Jet Propulsion Lab., Pasadena, Calif.). 30 Jul 1971. Contract NAS7-100. 22p. (NASA-CR-119690; JPL-TM-33-489). NTIS.

Two thermionic energy converters fueled with uranium nitride were fabricated and subjected to comprehensive tests to evaluate their performance as nuclear thermionic converters. Both converters had plane-parallel electrode geometry to increase the accuracy in making measurements of converter parameters and to simplify the laboratory testing which utilized an electron gun for the emitter heating. Of the two converters, one had a rhenium emitter and the other a tungsten emitter; the collector was niobium in both converters. The evaluation of fuel-emitter compatibility, the major objective of the laboratory tests, was performed by measuring and correlating converter characteristics and electrode work functions. The first phase of the evaluation, involving parametric testing, was completed. The initial performance of these converters was fully characterized so that any change that might occur during the second phase of the test, the life test, due to fuel-emitter interactions could be readily identified. (auth) (STAR)

2848 DECREASE IN POWER DENSITY DUE TO FINITE ELECTRODE CONDUCTIVITY IN LIQUID METAL MHD GENERATOR. Tanatugu, Nobuhiro; Fujii-E, Yoichi; Suita, Tokuo (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 10, 588-96(Oct 1971).

In the liquid-metal MHD power generator, the electric conductivity of the working fluid is so large as to be comparable with that of the electrode. Under such circumstances the perfect-conductor approximation no longer holds for the electrode, because the electric potential loses its constancy and acquires a certain pattern of distribution in the electrode as well as in the fluid. The extent of distortion in the electric equipotential lines and lines of force depends on the ratio of conductivity between electrode and fluid, and on the load connection. The power density becomes nonuniform, and furthermore the average power density becomes smaller than in the case of a generator with the perfect conductor electrode. The effect due to this finite conductivity of the electrode is contrary in trend to that due to end loss, as analyzed by Sutton with both aspect ratio and load factor as parameters. The results obtained in the experiments with a mercury blow-down facility agreed very well with the analysis. A numerical analysis was also made with end loss taken into account. (auth)

2849 MAGNETOHYDRODYNAMIC GENERATOR ELECTRODE. Yerouchalmi, David (to Commissariat a l'Energie Atomique). British Patent 1,250,112. 20 Oct 1971. Priority date 24 Jan 1968, France.

The MHD generator electrode described is comprised of a ceramic component consisting of at least 90 mole % of a magnesium spinel $MgO-Al_2O_3$ or $MgO-Cr_2O_3$ and containing an additive consisting of an alkaline-earth oxide (CaO, BaO, or SrO). (M.H.R.)

2850 THERMODYNAMIC CYCLES OF MHD CONVERSION WITH SEPARATION OF SINGLE-COMPONENT LIQUID-METAL WORKING FLUID AHEAD OF THE MHD GENERATOR. Kozlov, V. B. pp 59-65 of Teplo-Massoperenos v Odno- i Dvukhfaznykh Sredakh. /Alad'ev, I. T. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

A thermodynamic analysis was conducted on two possible designs of MHD converters with separation of the single-component liquid-metal operating fluid ahead of the MHD generator for blending streams prior to the nozzle (Design I), and behind the MHD-generator (Design II). The thermodynamic relations between parameters, the influence of parameter changes on the effectiveness, and the basic causes of irreversible energy losses were examined. The optimal initial vapor content at the exit from the heat source was determined. The dependence of cycle efficiency on initial vapor content was investigated. (tr-auth)

2851 NUCLEAR ENHANCEMENT OF CO_2 LASER OUTPUT. Rhoads, H. S.; Schneider, R. T. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc.; 14: No. 2, 429-30(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

2852 PARAMETER IDENTIFICATION OF A TWO-PHASE MHD GENERATOR BASED ON EXPERIMENTAL DATA. Hsu, C.; Marr, W. W.; Petrick, M. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 435-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Fluid Physics

Refer also to abstracts 2660 and 2861.

2853 DIRECT COMPUTATIONAL APPROACHES TO A MAGNETOHYDRODYNAMIC MODEL SYSTEM. Jeng, Dah-teng

(Univ. of California, Los Angeles). Computing: 7: No. 1-2, 1-12(1971).

The magnetohydrodynamic model system is integrated numerically as an initial-value problem. The system is integrated using two different numerical methods. The first uses a special finite-difference scheme introduced by Bellman. The second makes use of the classical method of converting a partial differential equation into an infinite system of ordinary differential equations. The formulation for each computational scheme is discussed, and a numerical example is presented. (auth)

2854 KELVIN–HELMHOLTZ INSTABILITY IN THE PRESENCE OF A UNIFORM ELECTRIC FIELD. Narasimha Murthy, S. (Indian Inst. of Science, Bangalore). Indian J. Phys.; 43: No. 12, 762-6(Dec 1969).

The interfacial instability arising due to relative motion of two fluids in the presence of a uniform electric field is studied. The parameters involved are a, b, c which denote the relative velocities, the electric part of the Maxwellian stress, and the surface tension, respectively. It is shown that, in the absence of surface tension and if $a + b > 1$, the system is unstable for all wave numbers. Moreover, if $a + b < 1$, the system is stable for wave numbers less than the critical wave number x_0, beyond which the system is unstable. Further, one notes that in the presence of surface tension when $a + b > 1$, the system is unstable below the critical wave number x_0', above which the system is stable. It was found that the increase in surface tension decreases the wave number band. On the other hand, if $a + b < 1$, the system is always stable for all permissible c. (auth)

Upper Atmosphere Physics

Refer also to abstract 2842.

2855 SCATTERING OF SOLAR X RAYS IN THE UPPER ATMOSPHERE. Hayakawa, S.; Kato, T.; Makino, F.; (and others) (Nagoya Univ., Japan). Rep. Ionosphere Space Res. Jap.; 25: No. 1, 1-16(Mar 1971).

The intensity of solar soft x rays scattered in the upper atmosphere is calculated. The intensity is so strong even if the Sun is under the x-ray horizon that the scattered solar x rays provide serious background against cosmic x rays. The result explains the intensity enhancement observed on the dawn side by cosmic x-ray experiments. The contribution of the scattered solar x rays relative to cosmic x rays is negligible if the zenith angle of the Sun is greater than 130°. (auth)

2856 CHARACTERISTICS OF LOW-LATITUDE WHISTLER PROPAGATIONS ASSOCIATED WITH MAGNETIC STORMS IN MARCH 1970. Okuzawa, Takashi; Yamanaka, Kaoru; Yoshino, Takeo (Univ. of Electro-Communications, Tokyo). Rep. Ionosphere Space Res. Jap.; 25: No. 1, 17-39(Mar 1971).

Storm-time variation of whistler propagations was investigated, using data from a low-latitude site, Sugadaira (geomagnetic lat. 26.0°N). The whistler data during the storm days and normal days in March 1970 are closely examined, observing closely the fundamental of the whistler ducts. Among five storms in March 1970, the moderate storm on March 5 and the severe one on March 8 influenced markedly the whistlers. (1) The rate of whistler occurrence increased at the very beginning of the severe storm, about 31 hours after the sudden commencement of the moderate storm, and the enhanced level remained for about 1 to 3 days after the SC of these storms. (2) During the storm periods, the dispersions of short whistlers were not in a depleted phase, but mostly in a slightly increasing phase. (3) The whistler diffusion on the whole began to increase at the very beginning of the severe storm, about 10 hours after the SC of the moderate storm, and the enhanced diffusion lasted for about 5 days from the SC of the severe storm, and possibly 3 days from the SC of the moderate storm. It is inferred that the formation of the ducts can take place in less than 30 minutes, and the destruction of the ducts can occasionally occur in an hour or less. (auth)

2857 FUNDAMENTAL EXPERIMENTS ON WAVE PHENOMENA IN SPACE CHAMBER PLASMA. Matsumoto, Hiroshi; Miyatake, Sadao; Kimura, Iwane (Kyoto Univ.). Rep. Ionosphere Space Res. Jap.; 25: No. 1, 40-58(Mar 1971).

An experimental study on wave phenomena in space plasma was performed in the Space Chamber installed in the Institute of Space and Aeronautical Science, University of Tokyo. In the Space Chamber, ion acoustic waves are often spontaneously excited, whereas it is also possible to excite the ion acoustic waves artificially by controlling the plasma parameters. It is shown that a nonlinear wave–wave interaction between the electron plasma waves and the ion acoustic waves is likely to occur. The fact is also shown experimentally that the spectrum of the ion acoustic waves excited by the nonlinear wave–wave couplings bears information about a delicate change of the plasma parameters. (auth)

2858 ROCKET EXPERIMENT OF ELECTRON DENSITY MEASUREMENT BY VLF DOPPLER AND PROBE METHODS. Kimura, I. (Kyoto Univ.); Hirao, K. Rep. Ionosphere Space Res. Jap.; 25: No. 1, 59-64(Mar 1971).

A K–9M rocket was launched at Kagoshima Space Center to compare two techniques for measuring the electron density in the ionosphere: the vlf Doppler technique and the Langmuir-probe technique. In the vlf Doppler experiment, a 40-kHz ground signal transmitted from Kemigawa near Tokyo and a 22.3-kHz signal transmitted from North West Cape in Australia were successfully received by the rocket. Two signals were received by the rocket from the 22.3-kHz source in the southern hemisphere, a downcoming signal that propagated to the rocket along the magnetic-field line and an upgoing signal that propagated through the Earth–ionosphere waveguide and then upward through the ionosphere to the rocket. In the Langmuir-probe experiment, the electron density was calculated from the probe current at a constant biased potential as well as at the space potential determined by a second harmonic method. (auth)

2859 SPORADIC E LAYER OBSERVATION BY A REFERENCE ELECTRODE OF THE ELECTRON TEMPERATURE PROBE. Oyama, K.; Hirao, K. (Tokyo Univ.). Rep. Ionosphere Space Res. Jap.; 25: No. 1, 65-9(Mar 1971).

Electron density of the lower E layer is evaluated from the floating-potential variation of a reference electrode of the electron-temperature probe. An observed E_s-layer structure is also presented that seems to give a useful clue to the formation of the nocturnal E_s layer. (auth)

2860 SPECTRAL STRUCTURE OF GEOMAGNETIC PULSATIONS DURING THE SEVERE MAGNETIC STORM ON MARCH 8, 1970. Saito, Takao; Sakurai, Tohru; Morioka, Akira (Tohoku Univ., Sendai). Rep. Ionosphere Space Res. Jap.; 25: No. 1, 70-5(Mar 1971).

Geomagnetic pulsations during the severe magnetic storm of March 8, 1970 were studied from the data recorded at Onagawa Magnetic Observatory. The normal-run and rapid-run magnetograms and the dynamic spectra of geomagnetic pulsations were analyzed by a high-speed spectrum analyzer, Hissa. Nine patterns are studied and compared to previous severe storms. The world magnetic-field variations during the first several hours from ssc on Mar. 8, 1970 are similar to those reported by Fukushima and Abe (1958) for the severe storms of Feb. 11, 1958; Jan. 24, 1949; and Aug. 5, 1933. The records at Abisko and San Juan on Mar. 8, 1970 are similar to those at Big Delta and Onagawa on Feb. 11, 1958, respectively. The geographical and local-time relations of these station-pairs are nearly the same. (J.C.W.)

2861 SELF-CONSISTENT STRUCTURE OF THE TRANSITION LAYER BETWEEN A COLD PLASMA AND A CONFINED MAGNETIC FIELD IN A ONE-DIMENSIONAL MODEL. Watari, Nobuo; Kamiyama, Hiroshi (Tohoku Univ., Sendai). Rep. Ionosphere Space Res. Jap.; 25: No. 2, 89-107(Jun 1971).

The steady-state transition layer between a cold plasma flow and a magnetic field is examined in detail in a one-dimensional model. The problem is formulated by combining Maxwell's equation, the equations of motion, the equation of continuity, and the boundary conditions. The solution is obtained analytically for any oblique incident angle with respect to the plasma–magnetic field interface. All of the physical quantities such as the electric and magnetic fields, the diamagnetic current, the electric potential, the charge density, the proton and electron number densities, fluxes, energies, and trajectories are given as functions of an incident angle and a position. The pressure balance is achieved when $B^2/8\pi = MN_0V_0^2$. An equilibrium transition layer may be established even in presence of the ambient plasma. Eventually, in the magnetosphere, it is suggested that the electric field generated in the transition layer infiltrates the magnetosphere due to the finiteness of the magnetospheric cavity. (auth)

2862 ELECTRIC CURRENT IN AND NEAR AURORA. Oguti, Takasi (Tokyo Univ.). Rep. Ionosphere Space Res. Jap.; 25: No. 2, 109-24(Jun 1971).

Electric currents in the vicinity of the auroral ionosphere such as those due to the plasma pressure gradient, charge precipitation, and auroral movement were examined. It was concluded that charge precipitation may be the cause of electric current shear at an auroral arc when the precipitating particle energy is high enough to penetrate down into the lower ionosphere where the electric conductivity is not so high. (auth)

2863 ANALYSIS OF MAGNETIC STORMS WITH DR-INDICES FOR EQUATORIAL RING CURRENT FIELD. Kamide, Yohsuke; Fukushima, Naoshi (Tokyo Univ.). Rep. Ionosphere Space Res. Jap.; 25: No. 2, 125-62(Jun 1971).

New indices designated as DR indices are introduced to express the ground magnetic perturbation due to the ring current in the magnetosphere. DR indices are derived from the geomagnetic H-component values at a number of stations at geomagnetic latitude 20 to 40° distributed almost equally in longitude. The observed H depression in low latitudes on the Earth's surface is represented by the magnetic effect of a model ring current in the equatorial plane at 4 Earth radii. The model ring-current system adopted here consists of an axially symmetric ring current and a partial one; the latter makes a closed-current circuit with field-aligned currents at both edges of the westward-flowing partial ring current and the eastward ionospheric line current at geomagnetic latitude 60°. The DR indices are determined to fit observed ground magnetic variation. The practical procedure to obtain DR indices is explained and a comparison of the DR indices with Dst and AE indices is made. (J.C.W.)

2864 LOCALIZED ABNORMAL GEOMAGNETIC DISTURBANCE NEAR THE GEOMAGNETIC POLE AND SIMULTANEOUS IONOSPHERIC VARIATION. Iwasaki, Noboru (Tokyo Univ.). Rep. Ionosphere Space Res. Jap.; 25: No. 2, 163-86(Jun 1971).

Attention is paid to a peculiar geomagnetic disturbance with reverse direction in the polar-cap region that takes place frequently when the magnetic activity in the auroral zone is weak. This kind of geomagnetic variation is here designated as the polar local abnormal disturbance (DP pole). It appears only in a localized region of geomagnetic latitudes higher than 75°, centering at about 83° in corrected geomagnetic latitude in the dayside hemisphere; it is not associated with the auroral electrojet, and it appears most frequently at about 13 or 14 hr of the corrected geomagnetic and geographic local times; it occurs most frequently in local summer and in solar-active years. The equivalent current system of the DP pole consists of two vortices near the geomagnetic pole, and the current flow over the pole is from the dayside hemisphere towards the nightside hemisphere, i.e., in a direction opposite to ordinary magnetic variations associated with the auroral electrojet. The local abnormal disturbance is found to be accompanied with a local increase in the electron density in the E region of the ionosphere, and possibly with an increase in the northward component of the interplanetary magnetic field. After examining the morphology of this localized abnormal disturbance in the polar region, the origin or the mechanism of the phenomena is discussed from the viewpoint of the interaction of the solar wind with the magnetosphere. (auth)

2865 MAGNETIC FIELD OF THREE-DIMENSIONAL MAGNETOSPHERIC MODEL CURRENT SYSTEMS AND CURRENTS INDUCED IN THE GROUND. Bostroem, Rolf (Royal Inst. of Tech., Stockholm). Acta Polytech. Scand., Phys. Nucl. Ser.; No. 77, 1-28(1971).

An account is given of methods to study the magnetic disturbances of model current systems including field-aligned currents. Direct integration, spherical harmonic expansion, and effects of currents induced in the ground are discussed and some examples given. (Sweden)

2866 PRELIMINARY OBSERVATIONS WITH A DIRECTIONAL IONOSONDE. Clarke, R. H. (Univ. of Queensland, Brisbane). Planet. Space Sci.; 19: No. 10, 1387-90(Oct 1971).

The addition of three spaced aerials and minor instrumentation to a conventional ionosonde permits the measurement of the angle-of-arrival of ionospheric reflections. Such a directional ionosonde (which is essentially a swept-frequency interferometer) is described, together with a derivation of the formulae relating the angles-of-arrival to the frequencies at which destructive interference occurs. The usefulness of such a system in the study of ionospheric irregularities (in particular, frontal irregularities) is stressed. (auth) (UK)

2867 ATMOSPHERIC OSCILLATIONS. III. Jones, Michael N. (Univ. of Hull, Eng.). Planet. Space Sci.; 19: No. 10, 1359-85(Oct 1971).

The theory of the oscillations of a planetary atmosphere is extended to the case of a perturbation arising from Hall conductivity. An explicit form is obtained for the system matrix, and the submatrix LX_2L, which determines the horizontal modal structure in the separable case, is shown to be Hermitian. The orthogonal eigenmodes of the latter are computed for zonal oscillations in a dipole magnetic field; they are qualitatively similar to Hough modes, but significant errors in equivalent depth and angular distribution will arise if an averaging procedure is used to convert the region to an equivalent Coriolis region. The horizontal modes of semi-diurnal oscillation are computed for a uniform Hall region of a rotating atmosphere, and are interpreted in terms of an isothermal model of the E region; a critical value of $\overline{\eta}_H \sim 1$ exists, beyond which negative modes become increasingly important in the description of low-l tidal motion, with an associated increase in reflection of tidal energy. A more-detailed model of the E region, taking into account the vertical variation of temperature and conductivity, and also the effects of Pedersen conductivity, will be considered later. (auth) (UK)

2868 LUNAR-SOLAR TIDES IN ELECTRON DENSITY AT FIXED HEIGHTS OF IONOSPHERE. Sharma, R. P.; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Planet. Space Sci.; 19: No. 10, 1349-57(Oct 1971).

Lunar tidal variations in the electron density N at fixed heights of the ionosphere for different solar hours were computed at the equatorial station, Huancayo, and the midlatitude station, Puerto Rico. It was found that the tidal amplitudes increased rapidly with altitude between 180 and 250 km. At Huancayo the phase, i.e., time of maximum positive deviation of lunar semi-diurnal variations in N, was 07–08 lunar hr for the lower regions (below 180 km); it changed sharply at heights around 200 km, above which it was 03–04 lunar hr. The amplitude of the tide at heights around 200 km was independent of solar hr. At Puerto Rico, the phase was continuously retarded with increasing height; it was about 01 lunar hr in E-region heights and changed to about 09–10 lunar hr at heights near h_{max}. It was seen that lunar oscillations in the E and F_1 regions, at both places, were in phase with corresponding magnetic field variations. Various observed results are explained as due to lunar variations in the magnetic field through the variations in the vertical electrodynamic drift velocities. (auth) (UK)

2869 HORIZONTAL DRIFTS ACCOMPANYING LARGE VERTICAL MOTIONS OF THE NOCTURNAL F REGION. Wright, J. W. (Environmental Research Labs., Boulder, Colo.). Planet. Space Sci.; 19: No. 10, 1327-37(Oct 1971).

A large-scale vertical convection of the mid dip-latitude postmidnight F region of the ionosphere is described; it occurred on about 60% of the local winter nights in each hemisphere in years of solar minimum activity and less frequently at other times. During the event the F region moved downward into the region of rapid recombination and most of its ionization may have been lost; a portion sometimes enters the E region to form a pre-sunrise E or sporadic-E layer. Spaced antenna measurements of F-region horizontal motions during these events are interpreted to support the view that the downward motion is driven by neutral air winds in the F region, rather than by electrostatic fields. (auth) (UK)

2870 ROCKET OBSERVATIONS OF MIDDLE-LATITUDE SPORADIC E, MAGNETIC FIELDS, WINDS, AND IONIZATION. Hall, S. H. (Univ. of Queensland, Australia); McDonald, D. G.; McGratten, G. J.; MacKenzie, E. C. Planet. Space Sci.; 19: No. 10, 1319-25(Oct 1971).

Two Skylark rockets carrying ion and rf electron probes, lithium and sodium vaporizers, and proton precession magnetometers were launched from Woomera, Australia in November and December 1965 and made at least four encounters with sporadic-E ionization. A magnetic field minimum was detected on only one of these encounters, and the minimum was found to be 2 to 3 km below the observed ion layer. The wind measurements deduced from observations of the vapor trails indicated that the sporadic-E layer occurred in a region of ion divergence. (auth) (UK)

2871 EMPIRICAL RELATIONSHIP BETWEEN IONOSPHERIC EQUIVALENT SLAB THICKNESS AND MEAN GRADIENT OF THE ELECTRON TEMPERATURE IN THE F REGION. Amayenc, P.; Bertin, F.; Papet-Lepine, J. (Faculte des Sciences, Paris). Planet. Space Sci.; 19: No. 10, 1313-17(Oct 1971).

It is shown that it is possible to define an empirical law between ionospheric slab thickness and mean gradient of the electron temperature in the F region. This law is obtained by using data of the incoherent scatter and can be used under certain conditions in connection with ionograms to find the electronic temperature and density profiles above the ionization maximum level. (auth) (UK)

2872 PLASMA-SHEET STRUCTURE AND ONSET OF MAGNETOSPHERIC SUBSTORMS. Hill, T. W.; Dessler, A. J. (Rice Univ., Houston, Tex.). Planet. Space Sci.; 19: No. 10, 1275-88(Oct 1971).

A model is presented in which the plasma sheet is not confined by a closed magnetic field configuration. Instead, the plasma-sheet particles continually leak down the tail along open field lines; the loss rate is controlled by particle scattering with magnetic field irregularities and waves, and the length of the plasma sheet is determined by loss of plasma-sheet particles to the neutral sheet. The escaping particles are replaced by continuous injection of

magnetosheath plasma entering the magnetosphere through the demarcation lines on the dayside magnetopause. According to the model, plasma-sheet particle fluxes at the lunar distance in the tail should normally be less than fluxes observed at the Vela orbital distance by a factor of two or more. The substorm onset in this model is the result of a depletion of the near-Earth plasma sheet owing to enhanced downstream escape. Thus the plasma-sheet "drop-out" observed at the Vela distance should be accompanied by a temporary enhancement of plasma-sheet flux at the lunar distance. Rapid magnetic merging then proceeds in the near-Earth neutral sheet by a simple "vacuum merging" process until the merging is slowed by the reappearance of the plasma sheet near the peak of the substorm. (auth) (UK)

2873 INFLUENCE OF THERMOSPHERIC WINDS ON AURORAL RED-LINE PROFILE OF ATOMIC OXYGEN. Hays, P. B.; Atreya, S. K. (Univ. of Michigan, Ann Arbor). Planet. Space Sci.; 19: No. 10, 1225-8(Oct 1971).

The effect of thermospheric winds on the emission profile of λ6300 is discussed. It is shown that meridional winds play a significant role in determining the shape of this emission, and the conventional diffusion of $O(^1D)$ hypothesis, though important, is not adequate to explain the observed features completely. (auth) (UK)

2874 MOTION OF ENERGETIC PARTICLES IN A MAGNETOSPHERIC MODEL INCLUDING A CONVECTION ELECTRIC FIELD. Kosik, Jean Claude Planet. Space Sci.; 19: No. 10, 1209-14(Oct 1971).

A magnetospheric model including convection and corotation electric fields was developed. Drift shells and pitch-angle evolution were obtained through perturbation methods. The asymmetry of the shell is maximum in a plane different from the noon–midnight meridian. As a consequence the dip in fluxes is not maximum in this meridian and the amount of shift is shown to be directly proportional to the convection electric field intensity, and inversely proportional to the energy or the pitch-angle of the particles. (auth) (UK)

2875 IONOSPHERIC HEATING AT ARECIBO: FIRST TESTS. Gordon, W. E. (Rice Univ., Houston, Tex.); Showen, R.; Carlson, H. C. J. Geophys. Res.; 76: No. 31, 7808-13 (1 Nov 1971).

The heating experiment of the ionospheric F region at Arecibo was produced by a powerful high-frequency transmitter and observed by the 430-MHz radar, an ionosonde, and several photometers. The equipment designs are described. The electron temperature of the ionosphere was increased by as much as 30% at and just below the height where the local plasma frequency was equal to the frequency (5.62 MHz) of a heating transmitter. By pulsing the heater (2 min on, 2 min off) and observing the electron temperature at various heights, time constants of 40 sec for the heating and of less than 10 sec for the cooling at 308 km were observed. Exploratory tests of an induced plasma-line radiation, an induced plasma motion, and an enhanced 6300-A radiation were conducted. (J.C.W.)

2876 DISCUSSION OF ROSS SECOND-ORDER EQUATION FOR DETERMINATION OF ELECTRON CONTENT. Basu, Sunanda (Jadavpur Univ., Calcutta); Basu, S. J. Geophys. Res.; 76: No. 31, 7817-19(1 Nov 1971).

Measurements of total electron content of the ionosphere have been in the last decade observing the Faraday rotation of the plane of polarization of signals transmitted by beacon satellites. The first-order equation derived from the relation between the polarization rotation and electron content of the ionosphere is given; assumptions in the equation are discussed. Considering the nonuniform distribution of ionization, the anisotropy of the medium in the presence of magnetic field, and the nonlinearity of refractive index with respect to electron density and magnetic-field intensity, Ross (1965) derived expressions for the separate ray paths for each mode by means of a polynomial expansion of the propagation equations. The Ross equation is used to determine the total electron content because its simplified form is amenable to a manual analysis. The effects of magnetoionic path splitting and ray wave–normal separation do not appear in his equation. The equation effectively evaluates Faraday rotation along the refracted path that the ray from the satellite would follow in the absence of the geomagnetic field. (J.C.W.)

2877 KINETIC MODELS OF THE SOLAR WIND. Lemaire, J.; Scherer, M. (Institut d'Aeronomie Spatiale, Brussels). J. Geophys. Res.; 76: No. 31, 7479-90(1 Nov 1971).

A new kinetic model of the quiet solar wind is presented and compared with earlier exospheric, semikinetic, and hydrodynamical models. To have equal mean free paths for the protons and electrons at the baropause, the ratio of the proton temperature to the electron temperature is supposed to be $T_p(h_0)/T_e(h_0) = 0.645$. With the assumption that the trapped electrons are in thermal equilibrium with those emerging from the barosphere, the electric-field distribution is calculated to cancel the electric current and space charge in the exospheric plasma. The bulk velocity, the density, the average electron and proton temperatures, and the energy flux, which are observed at 1 AU for quiet solar-wind conditions, are well represented by such a kinetic model. The average electron temperature is nearly independent of the bulk velocity, whereas a positive correlation between the average proton temperature and the bulk velocity is found. Consequently it is suggested that in the interplanetary medium (r > 6Rs) no external heating mechanism is needed to explain the observed quiet solar-wind properties. Finally, the electric-field calculations in this kinetic model are found to be in reasonable agreement with the empirical electric-field values deduced from observed coronal-density distribution. (auth)

2878 COLLISIONLESS SOLAR WIND. II. VARIABLE ELECTRON TEMPERATURE. Hollweg, Joseph V. (California Inst. of Tech., Pasadena). J. Geophys. Res.; 76: No. 31, 7491-7502(1 Nov 1971).

A two-component model for the solar wind is considered in which the protons become collisionless beyond $r_0 \geq 10\ R_S$, where they are already highly supersonic. The proton temperatures are found from the double adiabatic equation of state. The electrons are highly subsonic, and their temperature profile is prescribed ad hoc. Solar rotation is considered in a semi-self-consistent fashion. The momentum equations for the electrons and protons are solved subject to the conditions of quasi neutrality and zero charge efflux from the Sun. The proton thermal anisotropy is substantially reduced when solar rotation is considered. It is found that $T_{p||}/T_{p\perp} < 3$ if $r_0 = 40\ R_S$, while $T_{p||}/T_{p\perp} < 2$ if $r_0 = 55\ R_S$. The observed dependence of $T_{p||}/T_{p\perp}$ on solar-wind speed is consistent with collisionless flow, and the double adiabatic equation of state, beyond $r_0 = 55\ R_S$, if r_0 and $v_0 = v(r_0)$ do not change. Solar rotation leads to significantly lower mean proton temperatures, $T_p = (T_{p||} + 2T_{p\perp})/3$, than are obtained when the magnetic field is radial. Even slight electron anisotropy, $T_{e||}/T_{e\perp} \cong 1.2$, in the region $r > 10\ R_S$ reduces the solar-wind speed at the Earth by 10 to 15%, thus worsening the disagreement between observations and the two-fluid model. The electron-temperature profile in the supersonic region is the primary parameter determining flow acceleration there; we urge that the details of the electron energy balance, and the possibility of electron heating, be carefully examined in future work. (auth)

2879 HIGHER-MOMENT EQUATIONS AND DISTRIBUTION FUNCTION OF THE SOLAR-WIND PLASMA. Whang, Y. C. (Catholic Univ. of America, Washington, D. C.). J. Geophys. Res.; 76: No. 31, 7503-7(1 Nov 1971).

For a collisionless, heat-conducting plasma, the distribution function f is cylindrically symmetric about the direction of the magnetic field. If it is assumed $f = [1 + c_{||}\ h(c)]\ f_0$, where f_0 is the bi-Maxwellian distribution function, $c_{||}$ is the parallel component of the intrinsic velocity c, and h is an even function of c, then the fourth moments of f can be expressed as simple functions of lower moments. Thus, no higher moment terms appear in the third-moment equations. The two third-moment equations, which are obtained in a simple form, join other lower-moment equations to form a closed set of moment equations. The new equations can be used to study the thermal anisotropy and the heat flux of the solar-wind proton. A special case of the cylindrically symmetric distribution function $f = [1 + c_{||}h(c)]f_0$ is found to resemble the proton-distribution function reconstructed from solar-wind data, and this resemblance justifies the assumption needed for decoupling the moment equations. (auth)

2880 TEMPERATURE PROFILE OF SOLAR WINDS. Yeh, Tyan (New York Univ., N. Y.). J. Geophys. Res.; 76: No. 31, 7508-15(1 Nov 1971).

The temperature profile of the solar wind can be calculated from the energy equation by assuming that the velocity profile is known. When the logarithmic expansion rate of the solar wind is small, the heat-flow equation can be integrated analytically. If the coronal temperature is sufficiently high, the energy equation has a critical solution in which the temperature vanishes at infinity. A quiet-time temperature profile is calculated by using the observed data at the orbit of the Earth. (auth)

2881 REVERSE AND FORWARD SLOW SHOCKS IN THE SOLAR WIND. Burlaga, L. F. (Goddard Space Flight Center, Greenbelt, Md.); Chao, J. K. J. Geophys. Res.; 76: No. 31, 7516-21(1 Nov 1971).

Probable reverse and forward slow shocks were found in plasma and magnetic-field data from Pioneer 8. The shocks were oblique

and weak (Mach ~ 1.2). Numerous nonshock-like discontinuities were found with $B_1 \neq B_2$ and $n_1 \neq n_2$. It was observed that discontinuities with $B_1 \neq B_2$, $n_1 = n_2$ seldom if ever occur. (auth)

2882 THEORETICAL CONSTRAINTS ON THE MICROSCALE FLUCTUATIONS IN THE INTERPLANETARY MEDIUM. Barnes, Aaron (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res.; 76: No. 31, 7522-6(1 Nov 1971).

Theoretical constraints on the character of microscale fluctuations in the solar wind are examined. The microfluctuations could be either discontinuities or more smoothly varying structures. If the fluctuations are waves, they are probably mostly Alfvén waves (or rotational discontinuities), and if they are stationary structures, they are tangential pressure balances (or tangential discontinuities). It is formally proved that a true analog of the small-amplitude MHD "entropy wave" (or contact discontinuity) does not exist for collisionless plasmas. (auth)

2883 ENERGY AND MOMENTUM EXCHANGE IN TRANSVERSE PLASMA WAVES. Hollweg, Joseph V.; Voelk, H. J. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger. Institut fuer Extraterrestrische Physik, Garching, Ger.). J. Geophys. Res.; 76: No. 31, 7527-41(1 Nov 1971).

The energy and momentum changes both of a single particle and of a distribution of particles moving in a transverse electromagnetic wave propagating parallel to the direction of the average magnetic field are calculated. It is shown that energy and momentum conservation of the particles and of the electromagnetic field leads to the same dispersion relation as has been obtained by Stix (1962) from solution of the Vlasov equation. The transfer of energy and momentum between particles and fields is discussed in the context of stability or instability of the plasma. It is generally not sufficient to attempt to deduce the stability properties of a plasma from considerations of the energy gained or lost by the resonant particles alone. The additional constraint of momentum conservation and the effects of the nonresonant particles must be considered; this conclusion persists even in the limit of zero growth rate, when the resonant particles would be expected to play the dominant role. The real part of the frequency of the fire-hose instability is shown to be determined by momentum conservation, whereas the growth rate follows from energy conservation. For the new proton-resonant modes (Hollweg and Völk, 1970b), on the other hand, it is found that the growth rate follows from momentum conservation, whereas energy conservation yields the real part of the frequency. It is shown that the earlier classification of the proton-resonant modes in accord with the sign of $(A_p \pm \omega_r/\Omega_p)$ is, in fact, a classification assigned in accord with the gain or loss of energy by the protons. (auth)

2884 MATHEMATICAL MODELS OF OPEN MAGNETOSPHERE: APPLICATION TO DAYSIDE AURORAS. Forbes, T. G.; Speiser, T. W. (Univ. of Colorado, Boulder). J. Geophys. Res.; 76: No. 31, 7542 51(1 Nov 1971).

Two static mathematical models of the open or Dungey model of the magnetosphere are constructed. The process of construction is similar to that for early closed magnetosphere models, such as the Taylor–Hones model. The first model in fact is simply an addition of an interplanetary field in arbitrary direction to a Taylor–Hones image dipole model. In order to preserve the shape of the magnetosphere at high latitudes, and to partially exclude the exterior field, another model is constructed with the magnetopause approximated by a diamagnetic sphere. It is found that there are some interplanetary-field lines connected to the Earth for all orientations of the interplanetary field other than strictly northward, and that the maximum number of connected field lines occurs with a due southward field. For an average spiral hose angle of the interplanetary field, the dayside neutral point occurs on the magnetopause at about 10 o'clock local time. Dayside auroras, convection patterns, and other phenomena may exhibit symmetry about this local time. For a positive (negative) interplanetary-field sector, energetic, anisotropic particle fluxes should have direct access to the northern (southern) polar caps, as is supported by many recent observations. (auth)

2885 MAGNETOSPHERIC-FIELD DISTORTIONS OBSERVED BY OGO 3 AND 5. Sugiura, M.; Ledley, B. G.; Skillman, T. L.; Heppner, J. P. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 76: No. 31, 7552-65(1 Nov 1971).

Magnetospheric-field distortions are studied using approximately 10,000 data points sampled from the rubidium magnetometer measurements on Ogo 3 and 5. Analysis is made in terms of ΔB defined as the observed field magnitude minus the magnitude of a reference geomagnetic field. Average contours of equal ΔB are shown in the geomagnetic noon-midnight and dawn-dusk meridian planes for magnetically quiet (Kp = 0 to 1) and slightly disturbed (Kp = 2 to 3) conditions. These ΔB contour maps show (a) a high-latitude + ΔB region on the night-side and (b) an equatorial $-\Delta B$ region in the inner magnetosphere. For region a, the present survey, which extends approximately to 60°N dipole latitude in the relevant area, indicates a region of maximum ΔB at $\gtrsim 60°$ dipole latitude and at ~6 to 8 R_E near geomagnetic midnight. Region b, i.e., the equatorial $-\Delta B$ region encircling the Earth, shows greater inflation of the inner magnetosphere during magnetically quiet periods than the inflation usually assumed. The average minimum ΔB between 2 and 5 R_E is approximately $-40\ \gamma$ for quiet (Kp = 0 to 1) conditions and $-50\ \gamma$ for slightly disturbed (Kp = 2–3) conditions. The equatorial distribution of observed ΔB as a function of geocentric distance differs substantially from that expected from the well-known models of the quiet-time ring current. While the calculated model ring-current field has a minimum near the center of the ring-current belt and recovers appreciably before leveling off toward the Earth, observed ΔB decreases toward the Earth to distances $\lesssim 3$ R_E even at quiet times. (J.C.W.)

2886 GEOMAGNETIC-STORM PARTICLES IN THE HIGH-LATITUDE MAGNETOTAIL. Bame, S. J.; Hones, E. W. Jr.; Akasofu, S.-I.; Montgomery, M. D.; Asbridge, J. R. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res.; 76: No. 31, 7566-83(1 Nov 1971).

Nearly monoenergetic positive ions flowing outward along magnetic-field lines in the high-latitude magnetotail at ~18 R_E, outside the plasma sheet, were observed with Vela satellites. These ions, probably mainly protons, are detected only during geomagnetic storms. The "storm particles" have average energies per charge ranging from about 0.3 to 3 kV, but at any instant the energy distribution is quite narrow, sometimes <10%. Their angular distribution is usually narrow, sometimes ~6°. Particles with storm-particle characteristics are not observed in the plasma sheet. Storm-particle fluxes cannot be determined with high accuracy because of their narrow energy distribution, but they are estimated to reach 10^5 particles cm^{-2} sec^{-1} or more. Possible sources of the storm particles are considered, including the solar wind, magnetosheath, polar cusps, polar wind or ionosphere, plasma sheet, solar neutral hydrogen streams, reconnection transfer of plasma into the magnetotail from the polar cusps, polar wind, or polar ionosphere, and parallel electric-field acceleration of the polar wind or ionosphere ions along polar-cap magnetic-field lines. Of these possibilities, the electric-field acceleration is favored. No matter what their source, storm particles appear to be a new feature of geomagnetic storms. (auth)

2887 MAGNETOSPHERIC SUBSTORMS IN DISTANT MAGNETOTAIL OBSERVED BY IMP 3. Meng, C.-I. (Univ. of California, Berkeley); Akasofu, S.-I.; Hones, E. W. Jr.; Kawasaki, K. J. Geophys. Res.; 76: No. 31, 7584-94(1 Nov 1971).

Variations of the magnetic field and plasma sheet in the distant magnetotail (20 to 40 R_E) during magnetospheric substorms are studied on the basis of the Imp 3 magnetic-field and particle data. Depending on the locations of the satellite with respect to the boundary of the plasma sheet, the variations differ greatly. However, the present results and the results of other workers give a clear indication of an increase of the magnitude of the field outside the plasma sheet and of the simultaneous "thinning" of the plasma sheet during an early phase of substorms. At about the maximum epoch or during the recovery phase of substorms, the plasma sheet expands and appears to be inflated to at least the pre-substorm level. Furthermore, a large excessive flux of the magnetic (~Z component) field, as compared with the flux of the original dipole field, appears across the neutral sheet. (auth)

2888 ORIGIN AND EFFECTS OF ELECTRIC FIELDS DURING ISOLATED MAGNETOSPHERIC SUBSTORMS. Mozer, F. S. (Univ. of California, Berkeley). J. Geophys. Res.; 76: No. 31, 7595-7608(1 Nov 1971).

Balloon-measured electric-field data for 5-hour periods during each of 19 substorms near local midnight between L = 6.6 and 8.3 were analyzed and averaged to show that the ionospheric electric field is made up of approximately equal contributions from a large-scale field and small-scale turbulence. The large-scale field in a nonrotating frame of reference develops a westward component during the initial phase of an isolated substorm and an equatorward component about an hour later at the onset of the explosive phase of the substorm. The origin of the westward electric-field component is related to the connection of southward-turning interplanetary magnetic-field lines with terrestrial magnetic-field lines at the dayside magnetopause, and an example of this causal relationship is presented. The $E \times B$ drift of the nightside magnetosphere in response to this westward electric field results in the equatorward drift of auroral arcs, thinning of the plasma sheet, development of the tail-like magnetic-field geometry on auroral-zone magnetic-field lines, and many observed ground magnetometer effects. After about an hour, this drift also carries the night-

side magnetosphere into an unstable configuration in which instabilities deep within the magnetosphere trigger the explosive phase of the substorm. It is postulated that the equatorward component of the electric field that develops at this time is due to polarization of the ionosphere by Hall currents driven by the westward electric field. Absence of polarization before the explosive phase requires that field-aligned sheet currents flow into the ionosphere near the low-latitude boundary of the auroral zone and out of the ionosphere near its poleward edge during the initial phase of the substorm. The interruption of this current and the development of the westward Cowling current in the auroral electrojet are manifestations of the current reorganization occurring at the onset of the explosive phase. The poleward surge of auroral arcs and the thickening of the plasma sheet after the substorm explosion are not due to simple $E \times B$ drifts of the magnetosphere but may be related to the outward propagation of the instability that triggers the explosive phase of the substorm. (auth)

2889 OUTER-ZONE ELECTRON PRECIPITATION. Vampola, A. L.; Koons, H. C.; McPherson, D. A. (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res.; 76: No. 31, 7609-17 (1 Nov 1971).

Measurements of energetic electrons (300 keV to 2.3 MeV) within the drift loss cone, of elf emissions, and of the plasmapause location obtained with instruments aboard the polar satellite OV3-3 (1966-70A) are compared. A knee is found in the L-shell profile of the precipitated fluxes of outer-zone electrons, the flux decreasing toward lower latitudes. The location of the knee correlates with the morning location of the plasmapause but not with the evening location. This finding suggests that outer-zone electron precipitation is influenced by the morning (perhaps minimum) location of the plasmapause. For $3.3 \leq L \leq 4.3$, electrons are preferentially precipitated in the morning hours after 0600 LT. This precipitation corresponds to the strong morning maximum in the occurrence of whistler-mode elf emissions. Electromagnetic elf emissions are often observed near the plasmapause where the maximum flux of precipitated electrons is observed. (auth)

2890 OBSERVATIONS OF LOW-ENERGY (0.3 TO 1.8 MeV) DIFFERENTIAL SPECTRUMS OF TRAPPED PROTONS. Venkatesan, D. (Univ. of Calgary, Alberta, Can.); Krimigis, S. M. J. Geophys. Res.; 76: No. 31, 7618-31(1 Nov 1971).

Measurements of differential energy spectrums of trapped protons obtained from several passes during the period January to November 1969 using the polar-orbiting (inclination, 80.7°), low-altitude (2525 by 644 km) satellite Injun 5 are presented. The solid-state detector proton–electron telescope on Injun 5 consists of a 24-μ front element and two back elements of 862 and 905 μ, respectively, and provides several differential energy channels in the range 0.3 to ~25 MeV. The study reveals the existence of a quasi-persistent peak in the differential energy spectrum in the L range 2 to 2.6 and the energy range ~0.38 to 0.72 MeV. The average position of this peak is at $L \simeq 2.3$ and $E \simeq 0.54$ MeV, but both the position in L and the peak energy appear to vary with geomagnetic activity in an as yet undetermined manner. The fact that the shape of the spectrum is stable for several days or can change with time scales as small as 4 hours suggests an impulsive acceleration mechanism deep in the radiation belts like that suggested by other authors for energetic electrons. Other features of the spectrum show that the spectral parameter E_0 in the form $dj/dE = K \exp(-E/E_0)$ varies as $\sim L^{-3}$ in the L range 2 to 4, in general agreement with previous observations. The last result adds to the general body of evidence favoring diffusion from the solar wind as the primary mechanism for populating the radiation belts. (auth)

2891 DAYSIDE OF THE PLASMASPHERE. Chappell, C. R.; Harris, K. K.; Sharp, G. W. (Lockheed Palo Alto Research Lab., Calif.). J. Geophys. Res.; 76: No. 31, 7632-4 7(1 Nov 1971).

The concentrations of H^+ ions in the plasmasphere were measured by the Lockheed light-ion mass spectrometer aboard the Ogo-5 satellite. The data presented here cover the dayside region of the plasmasphere. These data were measured during the first year of operation of Ogo 5, March 1968 through February 1969. The position of the plasmapause on the dayside appears to be determined by the level of magnetic activity present during the previous corotation of the dayside sector through the formative nightside region. Once the sector has corotated past dawn, the plasmapause position does not immediately respond to changes in the level of magnetic activity. Observations of the buildup of H^+ density versus local time at L = 5 following magnetic storms indicate that H^+ ions flow from the dayside ionosphere into the plasmasphere and plasma trough. The upward flux must be of the order of 3×10^9 ions/cm^2 sec at 1000 km to account for the observed buildup of H^+ density. Regions of enhanced ambient-plasma density outside the main plasmasphere are observed in the dayside trough. These regions of detached plasma usually occur following periods of moderate to high magnetic activity and are observed most frequently in the afternoon–dusk sector of the plasma trough. Plasmapause density profiles in the afternoon–dusk sector show the effects of the dayside filling from the ionosphere. These effects consist of either smooth filling outside the steep gradient position, regions of detached plasma, or some combination of both. In addition, several of the dayside profiles display a steep drop in the H^+ density of about a factor of 10 inside the plasmapause position. As in the bulge and nightside regions, the characteristics of the dayside region of the plasmasphere can be explained in terms of a convection model of the magnetosphere in which the convection electric field varies in magnitude rather than remaining steady. (auth)

2892 CALCULATED AND OBSERVED FEATURES OF STABLE AURORAL RED ARCS DURING THREE GEOMAGNETIC STORMS. Roble, R. G. (National Center for Atmospheric Research, Boulder, Colo.); Norton, R. B.; Findlay, J. A.; Marovich, E. J. Geophys. Res.; 76: No. 31, 7648-62(1 Nov 1971).

Satellite electron temperature and density data are used to calculate the structure of several stable auroral red arcs (SAR arcs) according to the thermal-conduction model of the arc. The calculated λ6300-emission rates are compared with ground-based photometric observations taken at the same time and in the vicinity of the satellite crossings of the arcs. The SAR arcs analyzed include a range of λ6300 intensities, geographical locations, and times during the associated geomagnetic storm. In addition, satellite data were obtained at different altitudes over and within the SAR-arc region. Enhanced electron temperatures within or on the equatorward edge of an electron-density depression are common features of all the SAR arcs examined. There is general agreement between the calculated and observed λ6300-emission features for SAR arcs observed during the geomagnetic-storm periods of October 29 to November 2, 1968, May 14–15, 1969, and March 8–9, 1970. For these SAR arcs, thermal conduction from the magnetosphere alone is sufficient to excite the λ6300 emission to its observed intensity. (auth)

2893 λ5577 [O I] AND λ4278 N_2^+ EMISSIONS IN SAR ARC. Hoch, R. J. (Battelle Memorial Inst., Richland, Wash.); Smith, L. L.; Clark, K. C. J. Geophys. Res.; 76: No. 31, 7663-8 (1 Nov 1971).

Observations with scanning photometers at the Rattlesnake Mountain Observatory, Richland, Washington, show that at 1950–1953 PST the bright SAR arc of March 8–9, 1970, was definitely not exclusively emissions of atomic oxygen at λλ6300 to 6364 A. In this intense SAR arc (3.5 to 4.0 kR at λ6300) emissions at λ5577 and λ4278 were also recorded. The intensity ratio I(6300)/I(5577) was 26 ± 3 for a brief period; then the green λ5577 emission quickly faded below detectability. The λ4278 emission of N_2^+ was approximately 5 R in a 25-A band centered on 4278 A, and it also faded quickly. Detection of λ5577 in a SAR arc is rare and λ4278 has not been reported before. The presence of these minor emissions may be interpreted as inferring that the SAR arc is excited by electrons with a spread of energies. The nature of electron energy spectra that could cause the observed emission is discussed and the transient appearance of a small high-energy electron component is suggested. (auth)

2894 COORDINATED AURORAL-ELECTRON OBSERVATIONS FROM A SYNCHRONOUS AND A POLAR SATELLITE. Sharp, R. D.; Carr, D. L.; Johnson, R. G.; Shelley, E. G. (Lockheed Palo Alto Research Lab., Calif.). J. Geophys. Res.; 76: No. 31, 7669-82(1 Nov 1971).

The ATS-5 satellite in synchronous orbit and the OV1-18 satellite in a low-altitude polar orbit carried similar experiments to measure auroral-particle fluxes in the energy range from ½ to 50 keV. Simultaneous electron-flux observations are presented from 5 instances when the OV1-18 passed within a few hundred kilometers of the computed conjugate point to ATS 5. The integral flux levels were found to be generally comparable at the two locations with no evidence for angular distributions highly peaked along the field line. The spectrums were significantly harder at ATS 5 with average energies approximately a factor of 2 higher than at OV1-18. Evidence is presented for a dramatic difference in the shapes of the spectrums at the two locations with smoothly falling relatively featureless spectrums observed at ATS 5 and spectrums with a peak in the few keV range observed at OV1 18. Based on the 5 passes described, there is evidence that the trapped component of the flux increases more rapidly than the precipitating component during more active times. (auth)

2895 EVIDENCE NEAR THE AURORAL IONOSPHERE OF A PARALLEL ELECTRIC FIELD DEDUCED FROM ENERGY AND ANGULAR DISTRIBUTIONS OF LOW-ENERGY PARTICLES.

Reme, H.; Bosqued, J. M. (Centre d'Etude Spatiale des Rayonnements, Toulouse). J. Geophys. Res.; 76: No. 31, 7683-93(1 Nov 1971).

For about 115 sec of a French Dragon rocket experiment fired into a diffuse aurora from Andenes, Norway, at ~0440 GLT, a correlation was observed between electron-flux variations of 5 to 30 keV and proton-flux variations of 0.5 to 5 keV. The different features of particles during this event (energy spectra and angular distributions) can be interpreted with the presence along the geomagnetic-field lines of a 1- to 2-kV potential difference situated below an altitude of about 1500 km and accelerating positively charged precipitated particles. The origin of this electric field can be connected to instabilities due to the enhanced precipitation of electrons of 5 to 30 keV. (auth)

2896 LATITUDE AND TIME VARIATIONS IN PRECIPITATED-ELECTRON ENERGY INFERRED FROM MEASUREMENTS OF AURORAL HEIGHTS. Boyd, J. S.; Belon, A. E.; Romick, G. J. (Univ. of Alaska, College). J. Geophys. Res.; 76: No. 31, 7694-7700(1 Nov 1971).

Auroral-height measurements were made during a 5-month period of the IQSY using meridian scanning photometers at three stations spanning the auroral zone on the same dipole meridian. The measurements were restricted to stable homogeneous auroral arcs, which usually occur during quiet times between substorms. They refer to the height of maximum volume emission rate of λ5577 [O I] that in these arcs was found to coincide with that of λ4278 (N_2^+ first negative). The height of maximum emission of λ4278 is directly related to the characteristic energy of the precipitated auroral electrons. Sufficient triangulation data were obtained (1152 points) to allow a separation of the effects of local time and latitude, which are normally related through the diurnal motion of the auroral oval. Interpreted in terms of the precipitated electrons, the photometric data reveal that the distribution of characteristic electron energy has two components: (1) at any local time during the night the electron energy increases with decreasing latitude, and (2) at every latitude the electron energy increases with increasing time throughout the night. The flux of the precipitated electrons generally increases with time and decreasing latitude. It appears that stable homogeneous auroral arcs observed during quiet times between substorms are manifestations of convective particle motion in the magnetosphere and not of local acceleration mechanisms. (auth)

2897 ROCKET-BASED MEASUREMENT OF PARTICLE FLUXES AND CURRENTS IN AN AURORAL ARC. Vondrak, R. R.; Anderson, H. R.; Spiger, R. J. (Rice Univ., Houston, Tex.). J. Geophys. Res.; 76: No. 31, 7701-13(1 Nov 1971).

A rocket-borne auroral-particle experiment was fired from Fort Churchill, Canada, over a homogeneous arc at 2000 local time on February 26, 1969. Detectors measured the pitch-angle distribution of the fluxes of electrons with energies of 2 to 18 and >50 keV, and of protons with energies of 2 to 18 and 80 to 1000 keV. The downward (zero pitch angle) electron flux in the 2- to 18-keV interval reached $\sim 3 \times 10^8$/cm sec ster keV as the rocket passed over the visible arc at 135 km altitude. The total backscattered flux was about 20% of the downward flux in the same energy range. No protons in the 2- to 18-keV range, or any higher energy particles, were found in significant quantities. The north-to-south electron flux profile of the arc was roughly gaussian with a 10% intensity width of 10 km and a smaller secondary maximum to the north of the central maximum. Integration of the electron flux over pitch angle showed that the maximum net current density due to 2- to 18-keV electrons was 1.5×10^{-5} amp/m^2. The current density integrated across the arc width was equivalent to a sheet current of 0.08 amp/m. A vector magnetometer aboard the rocket indicated an upward current of 0.16 amp/m in the region of the downward flux. Comparison of these measurements shows that the energetic (>2 keV) auroral electrons carry a substantial part of the Birkeland current. The intensity and location of the electron fluxes were in reasonable agreement with measurements by ground-based photometers and all-sky cameras. The arc extended at least 1500 km in an east-west direction and was not associated with substorm activity. (auth)

2898 ROCKET-BASED MEASUREMENT OF BIRKELAND CURRENTS RELATED TO AN AURORAL ARC AND ELECTROJET. Park, R. J.; Cloutier, P. A. (Rice Univ., Houston, Tex.). J. Geophys. Res.; 76: No. 31, 7714-33(1 Nov 1971).

A rocket-borne experiment to study the currents associated with a quiet auroral arc was conducted at Fort Churchill, Canada, near 8 P.M. on February 26, 1969. The magnetic field in the vicinity of the arc was measured with a vector magnetometer, while a lunar-aspect sensor provided information on the orientation of the payload. Possible current configurations were inferred by constructing model current systems that reproduced the magnetic-field variations measured along the flight path. The data are interpreted in terms of a model current system consisting of a northwestward electrojet and two oppositely directed Birkeland sheet currents, all lying in planes approximately parallel to the auroral arc. The current density integrated through the 16-km thickness of each Birkeland current sheet was ~0.16 amp/m; the electrojet current was $\sim 6 \times 10^3$ amp. Comparison of the model currents with the electron fluxes detected by a separate experiment aboard the same rocket indicates that the upward Birkeland current and the electrojet were approximately coincident with the auroral arc as defined by precipitating electrons, and that 2- to 18-keV electrons carried roughly half the upward Birkeland current. The over-all current configuration differs from theoretical models proposed by Boström and Atkinson. (auth)

2899 SIMULTANEOUS MEASUREMENTS OF THE HYDROGEN AIRGLOW EMISSIONS OF LYMAN ALPHA, LYMAN BETA, AND BALMER ALPHA. Weller, C. S. (Naval Research Lab., Washington, D. C.); Meier, R. R.; Tinsley, B. A. J. Geophys. Res.; 76: No. 31, 7734-44(1 Nov 1971).

Lyman-α, 740- to 1050-A, and Balmer-α airglow measurements made at 134° solar-zenith angle on October 13, 1969, are compared with resonance-scattering models of solar radiation. Model comparison with Lyman-α data fixes the hydrogen column abundance over 215 km to 2×10^{13} cm^{-2} within a factor of 2. Differences between the Lyman-α model and data indicate a polar-equatorial departure from spherical symmetry in the hydrogen distribution. A Lyman-β model based on the hydrogen distribution found to fit the Lyman-α data fits the spatial variation of the 740- to 1050-A data well from 100 to 130 km, but it does not fit the data well at higher altitudes; thus the presence of more rapidly absorbed shorter-wavelength radiation is indicated. This same resonance-scattering model yields Balmer-α intensities that result in good spatial agreement with the Balmer-α measurements, but a fivefold increase in the measured solar line center Lyman-β flux is required (as required for the Lyman-β measurement). The intensity ratio of Lyman-β and Balmer α at night is found to be a simple measure of the hydrogen optical depth if measurements with good accuracy can be made in the visible and ultraviolet spectrum. (auth)

2900 LATITUDINAL SURVEY OF THE DAYTIME POLAR F LAYER. Pike, C. P. (Air Force Cambridge Research Lab., Bedford, Mass.). J. Geophys. Res.; 76: No. 31, 7745-53(1 Nov 1971).

Latitudinal cross sections of the bottomside polar F layer were constructed from ionograms recorded in an aircraft. Analysis of the cross sections shows that an F-layer irregularity zone occurs generally between 75 and 79° corrected geomagnetic latitude and from 0600 to 1800 corrected geomagnetic time in all 15 cross sections. Sequences of ionograms have been selected to illustrate how the F-layer behavior in the irregularity zone is different from the F-layer behavior at slightly lower and higher latitudes than the latitudes of the irregularity zone. Alouette-1 topside electron-density data, which show the location of the polar F-layer plasma ring and the polar F-layer cavity, are compared with the bottomside ionograms from the aircraft and show clearly that the bottomside F-layer irregularity zone and the topside plasma ring are the same feature and that the polar F-layer cavity is a feature common to both measurements. Good spatial correlation exists between the location of both the F-layer irregularity zone and the plasma ring and the location of the zone of soft-electron precipitation; thus soft-electron precipitation is suggested as the cause of the F-layer irregularity zone. (auth)

2901 NONLINEAR THEORY OF TYPE-I' IRREGULARITIES IN THE EQUATORIAL ELECTROJET. Rogister, Andre (European Space Research Organization, Frascati, Italy). J. Geophys. Res.; 76: No. 31, 7754-60(1 Nov 1971).

The nonlinear development of the Farley–Buneman instability in the equatorial electrojet was studied. The stabilization mechanism is a turbulent (negative) vertical electron flux $\langle \delta v_{e,x} \delta n \rangle$ that develops in the turbulent layer; to preserve charge neutrality, the (positive) vertical ion flux $\bar{n}\bar{v}_{i,x}$ decreases accordingly. Hence, the secondary electric field $\bar{E}_s = m_i \nu_i \bar{v}_{i,x}/q_i$, and the electrojet electron current $q_e \bar{n} \bar{v}_{e,y}$ also decreases, thereby quenching the instability. The predictions of the theory agree quite well with available experimental evidence. (auth)

2902 RELATIONSHIP BETWEEN Fe^+ IONS AND EQUATORIAL SPREAD F. Hanson, W. B.; Sanatani, S. (Univ. of Texas, Dallas). J. Geophys. Res.; 76: No. 31, 7761-8(1 Nov 1971).

Observations from the retarding potential analyzer on Ogo 6 near the magnetic equator demonstrate an intimate relationship between the presence of Fe^+ ions and irregularities in the total ion concentration. The ionospheric irregularities (or structure) are probably another manifestation of equatorial spread F, al-

though this has not been verified. Nearly half the nighttime equatorial crossings below 700 km exhibit both Fe^+ and structure, but only 10% of the passes without Fe^+ have structure. Approximately one-third of the passes with Fe^+ are not structured, which indicates that Fe^+ may be a necessary but not sufficient condition for structure formation. The Atlantic region shows an extremely high and detailed correlation between Fe^+ ions and the irregularities. (auth)

2903 PIONEER 8 PLASMA-WAVE MEASUREMENTS AT DISTANT BOW-SHOCK CROSSINGS. Scarf, Frederick L. (Space Sciences Lab., Redondo Beach, Calif.). J. Geophys. Res.; 76: No. 31, 7769-77(1 Nov 1971).

Enhanced low-frequency ($f \simeq f_p^+$, nf_c) plasma-wave levels were detected near the Pioneer-8 multiple bow-shock crossings encountered beyond 120 R_E (Bavassano et al., 1971). High-frequency ($f \simeq f_p^-$, f_{UHR}) plasma waves were also detected in the upstream region, and this finding suggests that the distant interaction of the solar wind and the magnetosheath produced nonthermal electrons of the type commonly found upstream from the subsolar shock. The bow-shock position is compared with fluid model predictions, and some distinctions between the standing bow shock and the propagating interplanetary shock are considered. (auth)

2904 CORRELATION BETWEEN CONVECTION ELECTRIC FIELDS IN THE NIGHTSIDE MAGNETOSPHERE AND SEVERAL WAVE AND PARTICLE PHENOMENA DURING TWO ISOLATED SUBSTORMS. Carpenter, D. L. (Stanford Univ., Calif.); Fraser-Smith, A. C.; Unwin, R. S.; Hones, E. W. Jr.; Heacock, R. R. J. Geophys. Res.; 76: No. 31, 7778-86(1 Nov 1971).

Several magneto-ionospheric wave and particle phenomena previously linked observationally to magnetospheric substorms and inferred to involve convection electric fields are correlated with whistler measurements of convection activity during two relatively isolated substorms. The events occurred at about 0600 UT on July 15, 1965, and about 0500 UT on October 13, 1965. The correlated phenomena include (a) cross-L inward plasma drifts near midnight within the plasmasphere, (b) diffuse auroral radar echoes observed near the dusk meridian, (c) IPDP micropulsations (intervals of pulsations of diminishing period) in the premidnight sector, (d) apparent contractions and expansions of the plasma sheet at about 20 R_E in the magnetotail, and (e) Pc 1/Pi 1 micropulsation events near or before midnight. Two new vlf phenomena occurred during the October 13 event, a noise band within the plasmasphere associated with a convecting whistler path and "hissiers," falling-tone auroral-hiss forms repeated at intervals of ~2 sec. (auth)

2905 SHELL SPLITTING DUE TO ELECTRIC FIELDS. Stern, David P. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 76: No. 31, 7787-90(1 Nov 1971).

Drift shells of trapped particles starting from a single field line in the Earth's magnetic field may become separated owing to an electric field. By using the formalism of the shell-splitting function, this separation is calculated for an arbitrary curl-free time-independent electric field satisfying $E \cdot B = 0$, with no limitation on the particle's longitudinal excursion. The effect of nondipole field components is also taken into account to the lowest order. (auth)

2906 ELECTROMAGNETIC ION-CYCLOTRON INSTABILITIES IN MULTICOMPONENT MAGNETOSPHERIC PLASMAS. Cornwall, John M.; Schulz, Michael (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res.; 76: No. 31, 7791-6(1 Nov 1971).

Growth rates for ion electromagnetic cyclotron (EMC) modes are calculated for several unconventional cases of magnetospheric importance, including total absence of cold plasma and presence of artificially injected heavy-ion plasma. Artificial injection of a very heavy ion such as barium or cesium is likely to suppress, rather than enhance, instability in the important ion-EMC mode, while injection of a light ion like lithium should be very effective in promoting instability in the ring current outside the plasmapause. (auth)

2907 QUENCHING OF VIBRATIONALLY EXCITED HYDROXYL (v = 9) WITH OXYGEN. Worley, S. D.; Coltharp, R. N.; Potter, A. E. (Manned Spacecraft Center, Houston, Tex.). J. Chem. Phys.; 55: No. 5, 2608-9(1 Sep 1971)

Radiative lifetime of vibrationally excited hydroxyl and the rate of reaction of hydroxyl with ozone were reported in an experiment when ozone was generated in a silent-discharge apparatus at concentrations of 5 to 7% in oxygen, so that substantial amounts of oxygen were present. It was implied that the role of oxygen as a quencher for hydroxyl was minimal. The reaction rates of hydroxyl with various atmospheric molecules including oxygen were studied and reported. The previous assumption was not proved incorrect, and it is pointed out that while O_2 was not significant as a quencher in the previous fast-flow experiment, it might be important as a quencher for the hydroxyl airglow in the upper atmosphere. Theoretical calculations indicate that the hydroxyl airglow should extend below 60 km during the daytime. Results in the reaction-rate measurement experiment indicate that the emission will be quenched by oxygen below 60 km, so that no airglow will be observed below that altitude. (J.C.W.)

2908 POSSIBLE MECHANISM FOR THE FORMATION OF IONOSPHERIC DISCONTINUITIES. Torbin, S. I.; Agalakov, V. S.; Sire, A. Sh. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 2, 217-21(Mar-Apr 1971).

Translated from Kosm. Issled.; 9: No. 2, 234-8(Mar-Apr 1971).

On the basis of analysis of data from observations on radio signals from artificial earth satellites and space equipment during the period from 1957 to 1962, experiments were undertaken of radio scintillation at short wavelengths. The existence was established of a diurnal and a latitude behavior of this scintillation. This effect is associated with the diffraction of radio waves by ionospheric discontinuities. In turn, it is confirmed that ionospheric discontinuities may arise because of subsidiary ionization of the upper layer of the atmosphere by streams of charged particles pouring out from the outer and inner regions of the Earth's natural radiation belt. A relation between scintillation of radio signals and individual geophysical phenomena was observed. (auth)

2909 CONCENTRATION OF NEUTRAL HYDROGEN IN THE UPPER ATMOSPHERE ACCORDING TO DATA ON THE IONIC COMPOSITION OF THE MEDIUM. Fatkullin, M. N. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 2, 228-39(Mar-Apr 1971).

Translated from Kosm. Issled.; 9: No. 2, 246-59(Mar-Apr 1971).

Measurement data on the ionic composition of the medium (in particular, on the concentrations of H^+ and O^+ ions with thermal energies) obtained by various methods (direct mass-spectrometer measurements made with rockets and satellites, observations of the incoherent scattering of radio waves, satellite observations of proton whistlers, etc.) were used to determine the concentration of neutral hydrogen in the Earth's upper atmosphere during a period around a solar activity minimum. The diurnal and height variations of H-atom concentration were calculated. The results are compared with data from direct measurements, indirect observations, and model calculations. (auth)

2910 DISTURBANCES IN THE LOWER IONOSPHERE AND THE OUTPOURING OF AURORAL PARTICLES DURING THE SUBSTORMS OF MARCH 24 AND 30, 1968. Ben'kova, N. P.; Bukin, G. V.; Val'ter, Zh.; Taieb, Sh. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 2, 274-8(Mar-Apr 1971).

Translated from Kosm. Issled.; 9: No. 2, 300-4(Mar-Apr 1971).

Investigations on the above subject reported by Vigneron et al., (Ann. Geophys., 25: 385(1969)), Kambu et al. (Kosm. Issled., 8: No. 4, 595(1970)), and Kleimenova, et al. (Compt. Rend., 269: 846 (Oct. 29, 1969)) are discussed further. (W.D.M.)

2911 HYDROMAGNETIC-NOISE SPECTRUM IN THE PROTON BELT. Gul'el'mi, A. V. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 2, 279-81(Mar-Apr 1971).

Translated from Kosm. Issled.; 9: No. 2, 304-6(Mar-Apr 1971).

The mechanism for the formation of a quasisteady-state hydromagnetic-noise spectrum in the proton belt is considered. The pitch-angle scattering of particles is completely neglected. (W.D.M.)

2912 EXPERIMENTAL EVIDENCE OF H^+, He^+, AND O^+ ION CURRENTS IN THE EXOSPHERE. Yaichnikov, A. P. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 2, 282-4(Mar-Apr 1971).

Translated from Kosm. Issled.; 9: No. 2, 307-9(Mar-Apr 1971).

For several months beginning with July 1964, instruments on Elektron-4 registered H^+, He^+, O^+, and N^+ ions in the exosphere at altitudes of 400 to 6000 km. Upon comparing computed data on the instrument's orientation with data on the variation of the currents of the components, additional maxima were discovered in the H^+, He^+, and O^+ currents. (W.D.M.)

2913 LATITUDE DEPENDENCE OF THE PARTICLE-RADIATION INTENSITY IN THE UPPER ATMOSPHERE. Komotskov, A. V.; Tulinov, V. F. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 2, 285-7(Mar-Apr 1971).

Translated from Kosm. Issled.; 9: No. 2, 309-11(Mar-Apr 1971).

Eight M-100 meteorological rockets equipped with SBT-9 Geiger end counters were launched in May–June 1969 to an altitude of 90 to 95 km in the Indian Ocean along the meridian 65°E. One of the launches was at relatively high latitude, four were at intermediate latitudes, and three were near the geomagnetic equator. (W.D.M.)

2914 POTENTIAL DISTRIBUTION AND IONIC CHARGE NEAR A LARGE EQUIPOTENTIAL SPHERE MOVING RAPIDLY IN A LOW-DENSITY PLASMA. Zhukov, V. V. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 2, 290-3(Mar-Apr 1971).

Translated from Kosm. Issled.; 9: No. 2, 313-17(Mar-Apr 1971).

The potential distribution and space charge were analyzed near a conducting sphere of radius 5.1 D (D = Debye radius) on whose surface the potential was specified to be $\varphi = -20$ kT/e and -80 kT/e in a flowing collisionless plasma consisting of one type of ion and of electrons. (W.D.M.)

Low-Temperature Physics and Cryogenic Equipment

Superfluidity

Refer also to abstract 3176.

2915 FIRST-SOUND MEASUREMENTS IN A 5 PERCENT ^{3}He–^{4}He MIXTURE. Barmatz, M. (Bell Telephone Labs., Murray Hill, N. J.). J. Low Temp. Phys.; 5: No. 4, 419-26 (Oct 1971).

Precision first-sound measurements at 17.1 kHz are presented for a 5% ^{3}He–^{4}He solution. Measurements near the λ transition are analyzed with a modified Pippard–Buckingham–Fairbank relation using recent ^{3}He–^{4}He heat-capacity measurements. The analysis takes into account the effects of gravity and dispersion. An accurate determination of $(\partial P/\partial\rho)_T$ is obtained from velocity measurements in the range 1.1 to 2.0 K. (auth)

2916 SCINTILLATION OF LIQUID HELIUM UNDER PRESSURE. II. 2 gt T gt 0.3°K. Roberts, Huey A.; Lee, William D.; Hereford, Frank L. (Univ. of Virginia, Charlottesville). Phys. Rev., A; 4: No. 6, 2380-5(Dec 1971).

Measurements of the α-particle-produced scintillation intensity of liquid He^4 under pressure were performed at temperatures ranging down to 0.3°K. The data show a strongly temperature-dependent component of the pulse intensity which drops to zero for $T \lesssim 0.75$°K. The principal pressure dependence of the intensity is in the component remaining below 0.75°K. A physical interpretation of the results is presented that invokes metastable systems and the superfluidity of He II to explain the temperature dependence and ionic recombination to explain the pressure dependence. (auth)

2917 ADDENDUM TO NEUTRON SCATTERING FROM LIQUID HELIUM II AT LARGE MOMENTUM TRANSFER AND THE CONDENSATE FRACTION. Kerr, W. C. (Wake Forest Univ., Winston-Salem, N. C. Argonne National Lab., Ill.); Pathak, K. N.; Singwi, K. S. Phys. Rev., A; 4: No. 6, 2413-15(Dec 1971).

A comparison of the recent experimental data for He-II of Cowley and Woods for the shift of the peak of the distribution of the inelastically scattered neutrons from the free-particle value appropriate for large momentum transfer is made with the phenomenological theory of Kerr et al. (auth)

2918 SCINTILLATION OF LIQUID HELIUM UNDER PRESSURE. I. 4.2 gt T gt 1.3°K. Manning, Robert J.; Agee, Forrest J. Jr.; Vinson, James S.; Hereford, Frank L. (Univ. of Virginia, Charlottesville). Phys. Rev., A; 4: No. 6, 2377-9(Dec 1971).

The intensity of α-particle-produced scintillations of liquid helium was measured in the 1.3 to 4.2°K temperature range and at pressures varying from the vapor pressure at 1.3°K to 28 atm. (auth)

2919 SPECIFIC HEAT OF LIQUID ^{3}He/^{4}He MIXTURES NEAR THE JUNCTION OF THE λ AND PHASE-SEPARATIONS CURVES. I. Alvesalo, T. A. (Technical Univ. of Helsinki, Otaniemi, Finland); Berglund, P. M.; Islander, S. T.; Pickett, G. R.; Zimmermann, W. Jr. Phys. Rev., A; 4: No. 6, 2354-68(Dec 1971).

The specific heat of liquid ^{3}He/^{4}He mixtures was measured at saturated vapor pressure for eight values of the ^{3}He mole fraction x in the range $0.53 \leq x \leq 0.73$ at temperatures from ~0.6 to ~1.4°K. For purposes of comparison, the specific heat of pure liquid ^{3}He was also measured under similar conditions. The measured specific heat, obtained with a calorimeter almost completely full of liquid, was corrected to yield the specific heat of the liquid $c_{P,x}$ at constant pressure and mole fraction. For the mixtures, the correction required was everywhere $\lesssim 1\%$. To a resolution in temperature that varies from 0.1 to 3 m°K from one value of x to another, the specific heat at the λ peak appears to be finite, continuous, and cusped. Both the λ peak and the discontinuity in $c_{P,x}$ as the system goes from the two-liquid-phase region to the one-liquid-phase region tend to disappear as the junction of phase boundaries is approached. (auth)

2920 VISCOSITY OF ^{4}He NEAR THE SUPERFLUID TRANSITION. Ahlers, G. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Lett.; 37A: No. 2, 151-2(8 Nov 1971).

An examination of available data for the viscosity η of ^{4}He near T_λ strongly suggests that η is singular at T_λ. (auth)

Superconductivity

Refer also to abstracts 2477 and 3474.

2921 (BNL-tr-453) EFFECT OF PRESSURE ON SUPERCONDUCTIVITY IN TRANSITION METALS. Khomskii, D. I. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Kratk. Soobshch. Fiz.; No. 6, 3-19(Jun 1971). 8p. Dep. NTIS.

The effect of pressure on superconductivity in transition metals is investigated on the basis of experimental data and recently completed theoretical investigations. (M.H.R.)

2922 (IAE-2028) POSSIBILITY TO INCREASE THE CRITICAL TEMPERATURE IN CASE OF THE PHONON MECHANISM OF SUPERCONDUCTIVITY. Geilikman, B. T. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 16p. (In Russian). INIS.

Equations for the energy gap and for the critical temperature T_c were examined for the case of superconductors with strong coupling, allowing for the dependence of the interaction constant on the phonon frequency. An effective interaction constant λ was calculated which determines T_c in Einstein models and the delta-function phonon peak. The constant was studied as a function of the customary interaction constant, the phonon frequency and impulse, the Fermi impulse, and other parameters. The maximum possible value of λ was found to be unity. A solution to the critical-temperature equation was found in cases of the delta function peak and the Einstein model. T_c possesses a sharp maximum in the second case, similar to an electron density function. (tr-auth)

2923 SUPERCONDUCTIVE COILS. Kanda, Eizo British Patent 1,250,145. 20 Oct 1971. Priority date 9 Jun 1969, Japan.

A superconducting coil is described in which each turn comprises layers arranged in the following sequence: a diffusion shielding layer; a superconductive material produced by subjecting a laminate of sheets of metal or alloy, in a ratio corresponding to the composition of the superconductive material, to a thickness reducing treatment and a heat treatment; a diffusion shielding layer; and a stabilizing layer comprising a normal conductor acting as an insulator. (M.H.R.)

2924 THEORY OF THERMAL DESTRUCTION OF SUPERCONDUCTIVITY BY A CURRENT. Overton, W. C. Jr. (Los Alamos Scientific Lab., N. Mex.). J. Low Temp. Phys.; 5: No. 4, 397-418(Oct 1971).

Earlier theories on the velocity of longitudinal propagation of the normal superconductive interface for a wire or strip carrying a current near the critical value are modified and extended. The importance of the role of the latent heat Q_L in a small elemental volume moving with the interface is determined; Q_L was ignored in previous theoretical work. A criterion inequality is developed that permits a qualitative test of the validity of the velocity calculated by any thermal theory. The conditions for a stationary value of the energy inside a moving interface volume element are determined. They lead to a new functional relationship for the velocity in terms of $T_t - T_B$, where T_t is the transition temperature and T_B is the bath or substrate temperature. Its intersection with the original v vs. $T_t - T_B$ function uniquely defines both in terms of various thermodynamic parameters. Sample calculations for a $Mo_{50}Re_{50}$ alloy illuminate several aspects of the theory. (auth)

2925 BOGOLYUBOV–VALATIN QUASI PARTICLES IN A FINITE SUPERCONDUCTOR. Varga, B. B.; Sienicki, James J.; Aks, Stanley Oe. (Univ. of Illinois, Chicago). J. Low Temp. Phys.; 5: No. 4, 495-8(Oct 1971).

The strong-coupling limit of the BCS model of a finite super-

conductor is analyzed mathematically, and the exact Bogolyubov–Valatin quasi-particle operators are found. These quasi-particle operators are "number conserving." The coefficients u_k, v_k and the quasi-particle energy are operators rather than constants, and they depend on the electron number density and the energy density. In the limit of large volume these densities become c numbers in an irreducible representation, and the quasi-particles are described by the usual Bogolyubov–Valatin transformation. (auth)

2926 MECHANICAL ANALOGS OF TIME-DEPENDENT JOSEPHSON PHENOMENA. Sullivan, D. B.; Zimmerman, J. E. (National Bureau of Standards, Boulder, Colo.). Amer. J. Phys.; 39: No. 12, 1504-17(Dec 1971).

The pendulum analog of a small-area Josephson junction between two superconductors is coupled to the analogs of other circuit elements to demonstrate a variety of time-dependent phenomena observed with actual devices. The analogy between electrical circuit and mechanical device is established through a Lagrangian formalism. The analog provides a simple and quick means of developing physical insight into this highly nonlinear system. To demonstrate the value of the analog, the problem of a junction coupled to a resonant cavity is considered as one example and a result that was missed by a previous solution is presented. (auth)

2927 FLUCTUATION EFFECTS IN THE ac CONDUCTIVITY OF THIN SUPERCONDUCTING LEAD FILMS AT MICROWAVE FREQUENCIES. Lehoczky, S. L.; Briscoe, C. V. (Univ. of North Carolina, Chapel Hill). Phys. Rev., B; 4: No. 11, 3938-51(1 Dec 1971).

Microwave transmission and reflection coefficients were measured for thin (<150 Å) lead films and for a lead film with thin manganese overlays (total thickness of overlay <5 Å) in the temperature range 5.0 to 7.3°K at frequencies of 23.89, 37.2, and 69.5 GHz. Well below $T_c[(T_c - T) \leq 0.2$ to 0.3°K], the temperature and frequency dependence of these ratios are in good agreement with theoretical values calculated using the complex conductivities derived by Mattis and Bardeen. Best fits with the experimental results were obtained using complex conductivities corresponding to a superconducting energy gap of $(4.5 \pm 0.2) \times k_B T_c$. Above T_c, both the microwave and dc data implied an excess conductivity for each film studied. This excess conductivity has been attributed to thermodynamic fluctuations in the Ginzburg–Landau order parameter for temperatures near the normal-to-superconducting phase transition. In agreement with the predictions of Aslamazov and Larkin for the two-dimensional limit, the dc measurements indicate a value of $0.152 \times 10^{-4}\ \Omega^{-1}$ for τ_0/R_n. Both the temperature and frequency dependence of the implied excess ac conductivity above T_c are accounted for by fluctuation-effect calculations of Schmidt. In the temperature region just below $T_c[(T_c - T) \sim 0.1$°K], the experimental results indicate an excess ac conductivity compared to the predictions of the Mattis and Bardeen (MB) theory. Recently, Schmidt has extended his theory of fluctuation effects in the ac conductivity to temperatures below T_c; combining these fluctuation-induced conductivities with those of MB (due to quasiparticles) permits the calculation of transmission coefficients in good agreement with experiment. This is believed to be direct evidence for fluctuation effects in a two-dimensional superconductor in the presence of quasi-long-range order. The deposition of a manganese overlay of approximately 2 Å upon a 150-Å lead film resulted in a 46% reduction in the microwave-measured energy gap. Essentially no charge was observed in the dc transition temperature. (auth)

2928 THERMODYNAMICS OF PRESSURE EFFECTS IN V_3Si AND V_3Ge. Sham, L. J.; Smith, T. F. (Univ. of California, San Diego, La Jolla). Phys. Rev., B; 4: No. 11, 3951-3(1 Dec 1971).

The thermodynamic relationships relating the pressure dependence of the superconducting transition temperature to the changes in the elastic constants at the transition are presented, and their application to the compounds V_3Si and V_3Ge is discussed. (auth)

2929 TEMPERATURE DEPENDENCE OF SURFACE-SHEATH NUCLEATION FIELD IN STRONG-COUPLING SUPERCONDUCTORS. Kirschenbaum, Jay (Queens Coll., Flushing, N. Y.); Kao, Yi-han. Phys. Rev., B; 4: No. 11, 4108-9(1 Dec 1971).

In an earlier paper the temperature dependence of H_{c_3} in a strong-coupling type-I superconductor was determined and compared with the theory of Eilenberger and Ambegaokar (EA). An error in the EA theory is now taken into account. The dc resistivity appropriate to the surface-sheath region has been obtained by a more consistent method. When these new factors are considered, the results suggest that the discrepancy between theory and experiment is due to a more fundamental reason than just experimental inaccuracy. (auth)

2930 RADIO-FREQUENCY TRANSMISSION IN INDIUM FILMS IN THE MIXED STATE. Bianconi, A.; Iannuzzi, M. (EURATOM–CNEN, Frascati, Italy). Phys. Rev., B; 4: No. 11, 3935-7(1 Dec 1971).

Radio-frequency transmission in amorphous indium films in the mixed state was investigated experimentally. The main new result was the observation of a broad dip bounded by two discontinuities at low levels of the radio-frequency magnetic field (a few gauss). This effect was studied as a function of the amplitude of the static perpendicular magnetic field, film thickness, and temperature. It is suggested that the experimental results may be explained as due to vortex motion in a pinning potential depending on the amplitude of the vortex oscillation. (auth)

2931 PATTERNS OF MAGNETIC FLUX PENETRATION IN SUPERCONDUCTING FILMS. Goren, Robert N.; Tinkham, M. (Harvard Univ., Cambridge, Mass.). J. Low Temp. Phys.; 5: No. 4, 465-94(Oct 1971).

Intermediate-state magnetic flux patterns were observed in thin superconducting films of tin, lead, and indium in perpendicular applied fields of 0.1 to 100 Oe. The spatial variation in flux density was measured very close to the film with a high-resolution Hall probe which could be scanned in a plane parallel to the surface of the film. The patterns appear to contain both laminar and round normal regions, with the latter predominant. A model for the intermediate state was developed in which the normal regions are macroscopic flux spots. Experimental results for the number density of these flux spots in 1.1 to 6.3-μ-thick indium samples are in good agreement with the temperature, field, and thickness dependences of the model; indium samples thinner than 1 μ appear to enter the mixed state. In tin and lead, however, the flux patterns are strongly influenced by flux pinning. Appearance of the flux pattern at the critical field or temperature was observed and correlated with distinctive features in the resistive transition. The extent of flux penetration into the sample was determined from measurement of the average field and compared for various field-temperature paths to the intermediate state. With the applied field reduced to zero, the magnetic field outside a current-carrying superconducting strip was measured and indicates that the current distribution within the strip is consistent with the form predicted by Bowers. (auth)

2932 SUPERCONDUCTIVITY: FUNDAMENTAL THEORETICAL ASPECTS AND RECENT APPLICATIONS. Giovanelli, Raffaele. Ingegneria; No. 5, 317-35(May 1971). (In Italian).

The above subject is reviewed under the following headings: examination of the theory of superconductivity and recent direction; Sommerfeld–Bloch theory of free electrons in normal metals; null resistance and critical magnetic fields; Meissner effect; description of field kinetics in presence of a superconductor; isotope effects; interval of forbidden energy; concept of coherence and theory of nonlocal dependence; surface energy; microscopic theory of superconductivity (BCS theory); magnetization and critical conditions; thermal treatment and cold working of Nb–Zr and Nb–Sn superconducting alloys; the Nb_3Sn ribbon superconductor; and present areas of research. An appendix is devoted to critical temperature T_c and critical magnetic field $H_c(T)$ deduced from thermodynamic considerations. 32 references. (L.M.T.)

2933 SUPERCONDUCTING PROPERTIES OF NIOBIUM CARBONITRIDE THIN FILMS. Gavaler, J. R.; Janocko, M. A.; Jones, C. K. (Westinghouse Research Labs., Pittsburgh). Appl. Phys. Lett.; 19: No. 8, 305-7(15 Oct 1971).

A method for preparing thin films of nominal composition $NbC_{0.3}N_{0.7}$ is reported. Maximum transition temperatures of 17.3°K are obtained for films deposited at ~700°C. However, higher critical currents and critical fields are obtained for films prepared at lower temperatures, even though the T_c's are lower. This effect is attributed to structural differences in the two types of films. (auth)

2934 PHYSICS OF SOLID STATE DEVICES. Beeforth, T. H.; Goldsmid, H. J. London: Pion Ltd. 204p. Pound 3.00.

One chapter in this book covering superconductors is in NSA scope. The subject is dealt with under the headings: applications of Type-I superconductivity (zero resistance, change of resistance near the critical temperature, limited current-carrying capacity of a superconductor, the critical-field transition, cryotrons and related devices, thermal switches), tunnelling effects (single-particle tunnelling, Josephson tunneling), and Type-II superconductors (high-field superconductivity, superconducting solenoids, inductive methods for the magnetisation of superconductors). (UK)

2935 WIGNER–SEITZ APPROXIMATION FOR THE DESCRIPTION OF THE MIXED STATE OF TYPE-II SUPERCON-

DUCTORS. Ihle, D. (Karl-Marx-Univ., Leipzig). Phys. Status Solidi (b); 47: No. 2, 423-8(1 Oct 1971).

The mixed state of Type-II superconductors is treated by means of the Wigner–Seitz approximation in the limit $\kappa \gg 1$ and $H_{c1} < H_a \ll H_{c2}$. Expressions for the magnetic field, supercurrent, magnetic induction, and lattice sums are derived. In order to test the accuracy of the Wigner–Seitz approximation the obtained results are compared with those derived by Fetter et al., good agreement being found. (auth)

2936 WIGNER–SEITZ APPROXIMATION FOR SOLUTION OF GINZBURG–LANDAU EQUATIONS. Ihle, D. (Karl-Marx-Univ., Leipzig). Phys. Status Solidi (b); 47: No. 2, 429-33 (1 Oct 1971).

In the mixed state of type-II superconductors the Ginzburg–Landau equations are solved by means of the Wigner–Seitz approximation for arbitrary applied magnetic fields between H_{c1} and H_{c2}. (auth)

2937 QUANTUM EFFECTS IN WEAKLY COUPLED SUPERCONDUCTORS. Leplae, L.; Mancini, F.; Umezawa, H. (Univ. of Wisconsin, Milwaukee). Phys. Lett.; 36A: No. 6, 475-6(11 Oct 1971).

The boson method in superconductivity is applied to the study of two superconductors weakly joined. A general theory of the ac effects is obtained; in particular, the presence of harmonic and subharmonic steps in the 1–5 characteristic of the system is derived. (auth)

2938 ACOUSTIC SURFACE-WAVE STUDY OF THE GINZBURG–LANDAU PARAMETER IN THIN LEAD FILMS. Jain, M. C.; Mackinnon, L. (Univ. of Essex, Colchester, Eng.). Phys. Lett.; 37A: No. 2, 111-12(8 Nov 1971).

The Ginzburg–Landau parameter was derived for thin superconducting films of lead by studies of the critical field using acoustic surface wave attenuation as the indicator of change of state. The results seem higher than those reported using other techniques; the temperature variation, however, seems consistent with present theory. (auth)

2939 RIGHI–LEDUC EFFECT IN Pb–In AND In–Pb ALLOYS. Sichel, E. K.; Serin, B. (Massachusetts Inst. of Tech., Cambridge. Rutgers–The State Univ., New Brunswick, N. J.). Phys. Lett.; 37A: No. 2, 123-4(8 Nov 1971).

The Righi–Leduc angles in the mixed state of Pb–In and In–Pb alloys have the opposite signs from the Hall angles in similar specimens. It is suggested that thermoelectric effects in the vortex cores are responsible for the observations. (auth)

2940 RELATIVE CONTRIBUTIONS OF SURFACE AND BULK HYSTERESIS TO PROPERTIES OF HOLLOW CYLINDERS OF TYPE-II SUPERCONDUCTORS. Schweitzer, D. G. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett.; 37A: No. 2, 147-8(8 Nov 1971).

Comparisons of the shielding and field-retaining properties of Type-II hollow cylinders in fields applied externally and in the void can be used to distinguish surface hysteresis from bulk hysteresis. (auth)

2941 CRITICAL ANOMALIES OF SUPERCONDUCTING INTERCALATED LAYER COMPOUNDS. Tsuzuki, T. (Institut Laue-Langevin, Garching, Ger.). Phys. Lett.; 37A: No. 2, 159-60(8 Nov 1971).

Both the specific heat and the perpendicular susceptibility behave as $(\ln T/T_c)^{-1}$ far above T_c and as $(\ln T/T_c)^{-\frac{1}{2}}$ very near to T_c. They are enhanced by a factor inversely proportional to the thickness of the metallic layers. While the parallel susceptibility does not show any measurable critical behavior. (auth)

2942 FLUCTUATION-INDUCED DIAMAGNETISM IN ALUMINUM. Kaufman, H. L.; de la Cruz, Francisco (Brown Univ., Providence). Solid State Commun.; 9: No. 20, 1729-32 (15 Oct 1971).

The magnetic field and temperature dependence of the magnetization of bulk aluminum near the normal–superconductor transition were measured. Due to the large amount of supercooling in one of the samples, it was possible to extend the measurements well below the critical temperature. A comparison of the experimental results with theory is presented. (auth) (UK)

2943 HEAT-CAPACITY MEASUREMENTS AND PHASE TRANSITIONS IN V_3Si. Viswanathan, R.; Luo, H. (Univ. of California, San Diego, La Jolla). Solid State Commun.; 9: No. 20, 1733-6(15 Oct 1971).

The superconducting transition temperatures of both cubic and tetragonal phases of V_3Si were observed unambiguously, for the first time, by heat capacity measurements based on the steady-state-calorimetry technique. They are separated by about 1°K. In pressed-powder compacts of V_3Si, another superconducting phase due to residual stress is found to occur with a transition temperature near 8°K. (auth)

2944 TEMPERATURE DEPENDENCE OF H_{c3}/H_{c2} NEAR T_c FOR Nb. Indovina, P. L.; Matzeu, M.; Onori, S.; Tabet, E. (Instituto Superiore di Sanita, Rome). Solid State Commun.; 9: No. 20, 1759-62(15 Oct 1971).

The ratio of the upper critical fields H_{c3}/H_{c2} of Nb was measured with a high-sensitivity differential technique in the reduced temperature range between 0.8 and 1. A sharp rise was found near T_c, in agreement with theoretical predictions based on a slightly modified Ginzburg–Landau approach. (auth) (UK)

2945 SUPERCONDUCTIVITY ABOVE 20°K IN STOICHIOMETRIC Nb_3Ga. Webb, G. W.; Vieland, L. J.; Miller, R. E.; Wicklund, A. (Radio Corp. of America Labs., Princeton, N. J.). Solid State Commun.; 9: No. 20, 1769-73(15 Oct 1971).

Superconducting transition temperature data are presented as a function of the β-W lattice constant in Nb–Ga alloys. T_c is a maximum for the lowest-lattice-constant material observed; this is identified as stoichiometric Nb_3Ga. The stoichiometric material is obtained by quenching from above a solidus followed by a low-temperature anneal. (auth) (UK)

2946 SURFACE-RESISTANCE MEASUREMENTS IN TE_{011}-MODE CAVITIES OF SUPERCONDUCTING INDIUM, LEAD, AND AN INDIUM–LEAD ALLOY AT LOW AND HIGH RF MAGNETIC FIELDS. Bruynseraede, Y.; Gorle, D.; Leroy, D.; Morignot, P. (CERN, Geneva). Physica; 54: No. 1, 137-59(30 Jul 1971).

The superconducting surface resistance of Pb, In, and $In_{0.92}Pb_{0.08}$ was measured between 1.5 and 4.2 K at low- and high-power levels in TE_{011}-mode cavities resonating at 2.85 GHz. A residual surface resistance of 9.4×10^{-8} ohms was achieved in the lead-plated cavity corresponding to a Q of 8.3×10^9. It is shown that the microscopic theoretical expression for the superconducting surface resistance adequately describes the experimental results for Pb and In, both Type-I superconductors, and for $In_{0.92}Pb_{0.08}$, a Type-II superconductor. In lead- and indium-plated cavities, and if heating effects are taken into account, the unloaded Q was observed to be essentially a constant up to the rf critical magnetic field B_c^f, where it abruptly decreased by a factor of 100 or more. This transition is characterized by breakdown oscillation phenomena. A B_c^f as large as 225 G for In and 750 G for Pb was observed. Measurements as a function of temperature indicated that the rf critical magnetic field of In and Pb is in agreement with the dc critical magnetic field. The largest measured B_c^f (~90 G) on the In alloy disc is a factor of 3 smaller than the lower dc critical magnetic field, B_{c1} (1.5 K) ~270 G. (auth)

2947 CRITICAL BEHAVIOR IN THE LINEAR RESPONSE OF A SUPERCONDUCTOR TO A STATIC MAGNETIC FIELD. de Pasquale, F. (Facolta di Ingegneria, Rome. Gruppo Nazionale Struttura della Materia, Rome); Tabet, E. Ann. Phys. (N. Y.); 65: No. 1-2, 35-52(15 Jun 1971).

The order parameter fluctuations are studied in the framework of the microscopic theory of superconductivity, both for $T > T_c$ and for $T < T_c$. The critical behavior of the local superfluid density $\rho_s(k)$ is investigated and the continuity of ρ_s in the critical region is explicitly shown. Long range correlations in the order parameter–order parameter correlation function T(q) are found below T_c. The link of the behavior of T(q) with the Goldstone mode induced by the gauge symmetry breakdown and the role played by long-range correlations in ensuring continuity in the critical region are discussed. Agreement with the phenomenological theory and with some previous results for $T > T_c$ is found. (auth)

2948 SINGLE-PARTICLE AND COLLECTIVE EXCITATIONS IN A SOLVABLE MANY FERMION SYSTEM. Richardson, R. W. (New York Univ., N. Y.). Ann. Phys. (N. Y.); 65: No. 1-2, 249-64 (15 Jun 1971).

A model Hamiltonian with a two-body interaction that is attractive in the $^1S_0$ and $^3P_0$ partial waves is shown to be exactly solvable for any number of fermions when the two partial waves have equal interaction strengths. It is shown that the ground state has the structure of a condensate of bound four-fermion subsystems. The excitation spectrum is shown to have two branches—a single-particle branch of the type usually found in superconductivity theory and a collective branch in which the excitation energies are of the order of 1/n, where n is the number of particles. The independent quasi-particle approxima-

tion, plus use of the cranking model, is shown to give the exact excitation spectrum of the collective states under certain circumstances. (auth)

2949 SUPERCONDUCTIVITY IN THE K, Rb, AND Cs TUNGSTEN FLUOROXIDE BRONZES. Hubble, F. F.; Gulick, Joan M.; Moulton, W. G. (Florida State Univ., Tallahassee). J. Phys. Chem. Solids; 32: No. 10, 2345-50(Oct 1971).

Tungsten fluoroxide bronzes are compounds of the general formula $M_xWO_{3-z}F_z$ where, for this investigation, M is an alkali metal and z = x. These compounds form dark blue or black hexagonal crystals for $0.08 < x < 0.30$. It has recently been demonstrated that Li dissolves in this crystal matrix to give compounds of the formula $M_xLi_yWO_{3-z}F_z$, where z = x + y for this investigation. Magnetization experiments performed on 24 of the above compounds show they are superconductors with transition temperatures generally between 0.8 and 4.5°K. The transition temperatures, T_c, upper critical fields, H_{c2}, and magnetization curves were measured for powder samples using the alkali metals K, Rb, and Cs, and empirical relationships between x and y and T_c and H_{c2} were established. The Abrikosov–Ginzburg and Gor'kov relations between H_{c2} and t provide a good fit to the Rb and Cs data respectively. (auth) (UK)

2950 STABLE SUPERCONDUCTING POINT-CONTACT WEAK LINKS. Buhrman, R. A.; Strait, S. F.; Webb, W. W. (Cornell Univ., Ithaca, N. Y.). J. Appl. Phys.; 42: No. 11, 4527-8(Oct 1971).

Mechanically stable, room-temperature–helium-temperature-cyclable insulated double and single point contacts were obtained by use of an insulating glass with thermal expansion matching that of the niobium superconductor. When two of these contacts are connected in parallel, the resultant device works quite well as a cyclable dc-biased magnetometer. (auth)

2951 NEW MODEL OF SUPERCONDUCTIVITY. Lalovic, D. I.; Tosic, B. S.; Zakula, R. B.; Skrinjar, M. J. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Phys. Status Solidi (b); 47: No. 1, 265-9(1 Sep 1971).

On the basis of a proposed model, a new condition for the occurrence of superconductivity is obtained. According to this condition, the possibility of high-temperature superconductivity exists. (auth)

2952 MICROSTABILIZED SUPERCONDUCTOR. Bergmann, Wilfried H. (to United States Atomic Energy Commission). U. S. Patent 3,600,281. 17 Aug 1971. Filed 18 Jun 1969.

This microstabilized superconductor contains a superconducting material of the hard Type-II series sized in cross sectional area less than 1000 times the coherence length of the material. (auth)

2953 CHANGES IN THE DEFORMATION STRESS IN THE SUPERCONDUCTING TRANSITION IN LEAD, INDIUM, AND TIN. Fomenko, V. S.; Startsev, V. I.; Pustovalov, V. V.; Didenko, D. A. Sb. Nauch. Tr., Fiz.-Tekh. Inst. Nizk. Temp., Akad. Nauk Ukr. SSR; No. 5, 228-41(1969). (In Russian).

Effects of temperature, deformation rate, and metal purity on the discontinuity of the deformation stress in Pb, In, and Sn during the superconducting transition were studied. A relationship was found between the superconducting transition and the deformation stresses in In and Sn. (Referativnyi Zh.)

2954 EFFECT OF PRESSURE ON CERIUM AND GADOLINIUM IMPURITIES IN LANTHANUM AND SOME LANTHANUM COMPOUNDS. Kim, Kang Soo. San Diego, Calif.; Univ. of California (1971). 117p. University Microfilms Order No. 71-26,574.

Thesis.

Depression of the superconducting transition temperatures (T_c) of La, $LaAl_2$, and La_3In by Ce impurities is anomalously large compared to the other rare earth impurities. This has been attributed to the proximity of the Ce 4f level to the Fermi level. Pressure was used to change the relative separation of these levels and study the magnetic character of the Ce impurities. The depression of T_c varies sensitively with pressure, exhibiting a maximum at some critical pressure and becoming much smaller at high pressure. As another result of the proximity of the Ce 4f level to the Fermi level, the above alloy systems show the Kondo effect. The Kondo effect in $La_{1-x}Ce_x$ alloys was studied by measuring electrical resistance at low temperatures to pressures as high as ~20 kbar, utilizing a newly developed Teflon pressure cell. The resistance (R) is nearly linear in ln T at low temperatures. The slope $|dR(T)/d \ln T|$, together with the depression of T_c, increases initially under pressure and then decreases. From the T_c and the resistance measurements, it is inferred that the Ce impurities undergo a pressure-induced magnetic–nonmagnetic transition. Unlike in the Anderson model, this transition seems to occur gradually as the Ce 4f level approaches the Fermi level. At the highest pressure available, the depression of T_c is, however, not zero, suggesting that the degenerate Ce 4f level nonetheless weakens superconducting pairs through resonance scattering. The resistance measurements also showed that potential scattering plays an essential role in determining the magnetic resistivity (resistivity due to the conduction electron–impurity spin exchange interaction) of $La_{1-x}Ce_x$. The T_c versus concentration curves of these superconductors containing Ce impurities deviate markedly, at normal pressure, from the results of the Abrikosov–Gorkov theory. In contrast to Ce impurities, Gd impurities in the above host metals do not change their magnetic character under pressure. (Diss. Abstr. Int., B)

Equipment and Devices

Refer also to abstracts 2338, 3475, and 3484.

2955 SIMPLE APPARATUS FOR SUSCEPTIBILITY AND MAGNETIZATION MEASUREMENTS ON SUPERCONDUCTORS. Lebeau, C.; Pinel, J. (Institut National des Sciences Appliquees, Rennes, France). J. Phys., E (London); 4: No. 11, 857-9(Nov 1971).

A simple apparatus designed to obtain direct and continuous recordings of the variation of the imaginary and real part of the susceptibility of a superconducting sample and of its magnetization was constructed. All these measurements can be made simultaneously and without disturbing the sample position. An example of results and typical sensitivities is given. (auth) (UK)

2956 DILUTION REFRIGERATOR TECHNOLOGY. Radebaugh, R.; Siegwarth, J. D. (Inst. for Basic Standards, Boulder, Colo.). Cryogenics; 11: No. 5, 368-4(Oct 1971).

Theoretical and practical developments concerning the ^3He–^4He dilution refrigerator are discussed. Properties of ^3He–^4He solutions are briefly discussed in terms of the weakly interacting Fermi–Dirac gas model and re-used to calculate the behaviour of dilution refrigerators. The thermodynamic behaviour of the dilution process is first discussed, and then an analysis of various types of heat exchangers is presented. The use of nearly optimum heat exchangers, designed by the method outlined here, can significantly reduce the liquid volumes required and/or reduce the low-temperature limit of the continuous dilution refrigerator. With smaller liquid volumes, the refrigerator can be cooled down and can reach thermal equilibrium more rapidly. Discussions of various practical considerations and recent developments in hardware are also included. Some suggestions for future work and speculations on trends are presented. (auth)

2957 CONSTRUCTION OF SOLENOID MAGNET WITH NEW ALUMINIUM STABILIZED SUPERCONDUCTOR. Nomura, H.; Obata, M.; Shimanoto, S. (Electrotechnical Lab., Tokyo). Cryogenics; 11: No. 5, 396-401(Oct 1971).

A solenoid magnet was constructed with a new anode-oxided aluminium-stabilized NbTi wire, in which Al and NbTi are directly bonded. An average current density of 16,800 A cm^{-2} at 49 kG was obtained. With this newly developed drawing technique, duralumin can be applied on the exterior as reinforcement, if needed. Now the construction of light-weight and high-current-density superconducting coils is possible for air-borne magnets, suspension magnets, etc. (auth)

2958 FORCED-CONVECTION HEAT TRANSFER TO SUPERCRITICAL HELIUM. Giarratano, P. J.; Arp, V. D.; Smith, R. V. (Inst. for Basic Standards, Boulder, Colo.). Cryogenics; 11: No. 5, 385-93(Oct 1971).

Heat transfer coefficients were measured for supercritical helium circulated around a closed-flow loop by a miniature centrifugal pump. Reynolds numbers in the 0.208-cm-id by 10-cm-long stainless steel test section ranged from 1×10^4 to 3.8×10^5 with pressures 3 to 20 atm (0.3 to 2 MN m^{-2}) and fluid temperatures 4.4 to 30 K. Wall-to-bulk temperature ratios varied from approximately 1.03 to 3.0. Results indicate an enhancement in heat transfer as the bulk temperature of the fluid approaches the transposed critical temperature. This improvement is qualitatively predicted by classical correlations due to the increase of thermal conductivity and specific heat in this region. Over the range of variables included in the measurements it was found that a modification of the Dittus–Boelter heat transfer correlation can be used to predict the heat transfer coefficient satisfactorily for most engineering calculations. (auth)

2959 IMPROVEMENTS IN OR RELATING TO SUPERCONDUCTORS. (to Maschinenfabrik Oerlikon). British Pat-

ent 1,250,998. 27 Oct 1971. Priority date 17 Jan 1969, Switzerland.

The superconductor described consists of superconducting strips having a conducting bond with the external surface of a hollow normally conducting support or carrier. (M.H.R.)

2960 DIRECT CURRENT GENERATOR FOR SUPERCONDUCTING CIRCUITS. (to Kernforschungsanlage Julich GmbH). British Patent 1,250,944. 27 Oct 1971. Priority date 18 Oct 1968, Germany.

A dc generator for superconducting circuits is described, including a vacuum vessel, one or more plates arranged therein, and two metal blocks. One set of edges of the plates is soldered to one metal block and the other set of opposite edges of the plates is soldered to the second metal block. A plurality of ribs is provided on each metal block. A heating coil is located around one set of ribs; the other set of ribs is immersed in liquid helium situated outside the vacuum vessel. The plates consist of an alloy or elemental metal that produces a thermoelectric voltage between the soldered joints, which are maintained at two different temperatures. (M.H.R.)

2961 DESIGN FOR A SUPERCONDUCTING a.c. POWER CABLE. Rogers, E. C. (British Insulated Callender's Cables Ltd., London); Slaughter, R. J.; Swift, D. A. Proc. Inst. Elec. Eng. (London); 118: No. 10, 1493-1500(Oct 1971).

A design study for a 750-MVA 33-kV superconducting ac power cable is described. Conductor and dielectric design, thermal insulation and refrigeration, and methods of construction and installation are all considered. Niobium is the chosen conductor material, and a triple coaxial construction the chosen conductor geometry. The capital costs of the systems considered are estimated to be rather more than twice that of the equivalent 275-kV conventional oil-filled cables. The running costs are about the same as that of the conventional equivalent, but represent only a small proportion of the total cost. Problems that need further study and development work, and whose solution could lead to significant design improvements and cost reductions, are: protection of the conductors against current overload, thermal contraction, and dielectric design. It is concluded that, though superconducting cables are unlikely to be economical at the power level considered in the study, they may find application in the multi-GVA region. (auth)

2962 CONSTRUCTION AND OPERATION OF A NUCLEAR REFRIGERATION CRYOSTAT. Gylling, R. G. (Helsinki Univ. of Tech., Ontaniemi, Finland). Acta Polytech. Scand., Phys. Nucl. Ser.; No. 81, 1-66(1971).

Thesis.

In this cryostat a powerful dilution refrigerator and a superconducting solenoid wound with filamentary NbTi wire were combined to produce the initial conditions $T_i = 16$ mK and $B_i = 5$ Vs/m^2 for nuclear demagnetization experiments. A large specimen containing 12 moles of copper was demagnetized and the external heat leak was reduced to 10^{-9} W/mole. The thermometry consisted of a pulsed NMR thermometer with which the temperature of copper nuclei at a distance from the demagnetization region could be measured. This thermometer was calibrated against a ^{54}Mn-in-nickel nuclear orientation thermometer, and the linearity of the NMR thermometer was checked by measurements of the spin–lattice relaxation time of copper down to a temperature of 1 mK. The uncertainty in the reported temperatures was thus reduced to 5%. The minimum temperature recorded in a final magnetic induction of 0.036 Vs/m^2 was 0.54 mK. This was found to correspond to a minimum electron temperature of 0.37 mK in the demagnetization region, significantly lower than ever before achieved. Temperatures below 2 mK were maintained for 12 hours, demonstrating the feasibility of this apparatus for research in this temperature region, which cannot be reached by any other known method of refrigeration. (auth) (FINLAND)

2963 CRYOSTAT FOR X-RAY SCATTERING AND FOR NUCLEAR γ-RESONANCE AND ANGULAR CORRELATION STUDIES AT HIGH PRESSURES. Syassen, Karl; Christoe, Charles W.; Holzapfel, W. B. (Technische Univ., Munich). Z. Angew. Phys.; 31: No. 5-6, 261–2(1971).

A high-pressure cell for x-ray scattering, nuclear γ-resonance spectroscopy, and nuclear γ angular correlation studies on solids at temperatures between 4.2 and 350°K and pressures between 0 and 180 kbars is described. The operation of the cell in x-ray scattering experiments on NaCl and Ag at various pressures and temperatures is discussed. (auth)

Plasma and Thermonuclear Physics

Refer also to abstract 2196.

2964 PLASMA PHYSICS INDEX. VOLUME 6, NO. 9, 1971. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 137p.

This listing contains 421 references on various aspects of plasma physics. (M.O.W.)

2965 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. VOLUME 5, NO. 8, 1971. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 47p.

This list contains 154 references on various aspects of controlled thermonuclear research. (M.O.W.)

2966 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. VOLUME 5, NO. 9, 1971. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 53p.

This listing contains 273 references on various aspects of controlled thermonuclear research. (M.O.W.)

Confinement and Heating

2967 (CTO-766) HELICAL MAGNETIC CONFIGURATIONS WITH MINIMUM B. Zueva, N. M. (Akademiya Nauk SSSR, Moscow. Institut Prikaadnoi Matematiki). Translated by J. B. Sykes (Culham Lab., Abingdon, Eng.), from Russian Preprint No. 5. 18p. Dep. NTIS (U. S. Sales Only).

One class of helical fields is examined and their structure is elucidated. Fields having a magnetic well on the axis are analyzed in detail. (auth)

2968 (NP-19060) ANOMALOUS RESONANCE IN SHF HEATING OF ELECTRONS IN MAGNETIZED PLASMA. Preprint No. 95. Batanov, G. M.; Sarksyan, K. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1971. 9p. (In Russian). Dep. NTIS (U. S. Sales Only).

SHF heating of electrons in a magnetized, collisionless plasma is experimentally analyzed in the region of magnetic fields for which $\omega_{eH}/\omega_0 \geq 1$. Resonances were detected in the dependence of heating efficiency on the magnetic field. Electrons are most efficiently heated when $\omega_{eH}/\omega_0 \approx 1$, $\omega_{eH}/\omega_0 \approx 1.4$ to 1.5 and $\omega_{eH}/\omega_0 \approx 1.9$ to 2. The dependence of heating efficiency on plasma density is also of a resonance character for $\omega_{Le}/\omega_0 > 1$. The discovered effects are related to parametric excitation of potential waves in the plasma. (J PRS)

2969 INJECTION OF STREAMING PLASMA INTO A MIRROR MACHINE. Johnson, Brian Weatherred. Pittsburgh; Carnegie-Mellon Univ. (1970). 128p. University Microfilms Order No. 71-24,855.

Thesis.

Shock trapping of helium plasma in a mirror machine is experimentally investigated. The neutral helium plasma is axially injected into a symmetric double magnetic mirror. The plasma is created by a conical theta-pinch gun energized by a 2.5-kJ capacitor bank. The double magnetic mirror has a maximum field strength of 4 kG and a mirror ratio of 3.3 or 6.7. The density range is 10^{14} to 10^{15} particles/cm^3. Parallel electron temperatures are 10 to 20 eV and transverse temperatures are 2 to 10 eV. Mach numbers range from 0.3 to 0.5. Beta ranges from 0.05 to 0.35. Confinement time measured by a 65-GHz interferometer increases with increasing magnetic field to a maximum of 250 μsec at a mirror field strength of 4 kG. With a mirror ratio of 3.3 a shock is predicted and observed in the second mirror. The shock converts axial energy of the plasma into transverse energy, thereby slightly enhancing trapping of the plasma in the mirror region. With a mirror ratio of 6.7, a shock is not predicted and not observed because the Mach transition does not occur in the second mirror. (Diss. Abstr. Int., B)

Diagnostics

Refer also to abstract 3048.

2970 (CLM-P-201) MEASUREMENT OF LIGHT SCATTERED FROM DENSITY FLUCTUATIONS WITHIN A COLLISIONLESS SHOCK. Paul, J. W. M.; Daughney, C. C.; Holmes, L. S. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). May 1969. 9p. Dep. NTIS (U. S. Sales Only).

Measurements were made of the scattering of laser light from the microturbulence within a collisionless shock. The measure-

ments demonstrate the presence of ion waves with a fluctuation level, which is sufficient to explain the observed collisionless heating within the shock. (auth)

2971 (EUR-CEA-FC-600) T_i DIAGNOSTICS USING THE INCOHERENT SCATTERING OF A MILLIMETER WAVE BY A PLASMA WITH $n_e \sim 10^{13}$ el/cm^3. Lepechinsky, D. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1971. 5p. (In French). Dep. NTIS (U. S. Sales Only).

A T_i diagnostic using the incoherent scattering of a 10-watt millimeter wave (λ = 2 mm) by a plasma with 5×10^{13} el/cm^3 and T_e = 100 eV is demonstrated to be possible from the point of view of signal/noise ratio. The difficulty arising from the choice of filter for the central frequency of the spectrum is emphasized ($\Delta f/f \sim 1/1500$ at 150 GHz). (France)

2972 TEMPERATURE MEASUREMENTS OF PLASMAS PRODUCED BY LASER PULSES IN GAS JETS. Neusser, H. J.; Puell, H.; Kaiser, W. (Technische Univ., Munich). Appl. Phys. Lett.; 19: No. 8, 300-2(15 Oct 1971).

Laser-produced plasmas generated in a freely expanding N_2 gas jet of high density are investigated experimentally. Measured values for the electron temperature and the time of light–plasma interaction are presented as a function of the incident light power. The results are compared with existing theories. (auth)

2973 SYNCHRONIZED RAPID-SCANNING MULTICHANNEL SPECTROMETER. Urano, Yoshio; Kosasa, Kyoko; Maruyama, Yoshio (Government Industrial Research Inst. Osaka). Jap. J. Appl. Phys.; 10: No. 11, 1592-6(Nov 1971).

A rotating mirror driven by a current pulse is combined with a multichannel spectrometer to enable a rapid scanning of spectra. The speed and range of its wavelength scan are 0.6 Å/μsec and 80 Å respectively, using a spectrometer of dispersion of about 5 Å/mm. The rotating mirror effectively changes the position of the virtual entrance slit, and a wavelength scanning can be done at the exit slits, which are fixed on the Rowland circle. The current pulse that drives the rotating mirror can be triggered from, and so the scanning can be synchronized with, the phenomenon to be observed. A device that gives a wavelength scale on an oscilloscope trace of the scanned spectrum is also included. (auth)

2974 EXPLANATION OF ANOMALOUS SCATTERING OF LASER LIGHT FROM AN ARC PLASMA. Infeld, E.; Zakowicz, W. (Inst. of Nuclear Research, Warsaw). Phys. Lett.; 37A: No. 2. 103-4(8 Nov 1971).

It is found that plasma oscillations lead to peaks in the scattered light spectrum shifted by not only ω_p, but also by multiples of ω_p. The spectra are found analytically, and a method for deducing amplitudes of plasma oscillations is indicated. (auth)

2975 REFRACTION EFFECT OF CO_2 LASER BEAM BY PLASMA. Nakatsuka, M.; Yokoyama, M.; Izawa, Y.; Toyoda, K.; Yamanaka, C. (Osaka Univ.). Phys. Lett.; 37A: No. 2, 169-70(8 Nov 1971).

Spatial phase modulation of laser beam by plasma is computed by two-dimensional configuration. It is possible to estimate an electron density from experimentally measured refraction of CO_2 laser beams by plasma. (auth)

2976 CORRELATOR FOR INVESTIGATING RANDOM PROCESSES IN A PLASMA. Rodichkin, V. A.; Serebrenyi, G. A.; Timonin, A. M. (Scientific-Research Inst. of Electrophysical Equipment , Leningrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 177-9(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 151-3(Jan-Feb 1971).

A correlator circuit used to investigate turbulent fluctuations in the plasma of a powerful quasi-stationary gas discharge is described. Standard delay lines and a multiplication stage based on semiconductor diodes are used in the circuit. The choice of circuit parameters is substantiated, and the characteristics of its elements are given. (auth)

2977 NONISOTHERMAL THEORY OF AN ELECTROSTATIC PROBE IN A WEAKLY IONIZED GAS. Jou, Wen-huei. Princeton, N. J.; Princeton Univ. (1971). 108p. University Microfilms Order No. 71-23,363.

Thesis.

In the existing literature on the diffusion theory of the interaction between a weakly ionized plasma and a solid surface, the electron temperature is assumed to be constant. This assumption is dubious. For an absorbing probe immersed in a plasma, asymptotic theories based upon the small Debye length can be developed with electron energy balance taken into consideration. Detailed development is given here for both the cases when ions are much colder than electrons and when the temperatures of the two charged species are of the same order. The main results are as follows: (1) current–voltage characteristics of the probe can be represented by an asymptotic series in which the leading term is the probe potential obtained under quasi-neutral approximation; (2) in general, the sheath scales are different from those obtained in isothermal theory and depend on the current (or probe potential) and the temperature ratio of the two charged species; (3) the cold-ion approximation is valid only when the ion temperature is much lower than the electron temperature in both the quasi-neutral region and the sheath; and (4) the ion current approaches the saturation value at a probe potential lower than that given by the isothermal theory. The present two-fluid model was applied to an electron-emitting probe without satisfactory results. It is conjectured that a three-fluid model, one ion fluid and two electron fluids, may be necessary for treating probes with strong electron emission. (Diss. Abstr. Int., B)

2978 SOLUTION OF COLLISIONLESS PLASMA FLOWS OVER CONICAL LANGMUIR PROBES BY A DISTANCE-ASYMPTOTIC TECHNIQUE. Greenblatt, Marshal. Princeton, N. J.; Princeton Univ. (1971). 218p. University Microfilms Order No. 71-23,359.

Thesis.

The flow of a collisionless plasma over various conical Langmuir probes, including flat plates, wedges, cones, and delta wings is solved. The flow speed is assumed intermediate between the ion and electron thermal speeds. Chemical reactions are ignored. The ion temperature is ignored and the electrons are taken to be isothermal. The body is charged to a highly negative potential, so the electron current is negligible. (TSS) (Diss. Abstr. Int., B)

2979 PULSED IONIZATION CHAMBER KINETICS STUDIES OF GASES IONIZED BY NUCLEAR METHODS. Ellis, W. H.; Imani, K. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc.; 14: No. 2, 431-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Kinetics (General)

2980 (CONF-711021–2) PRODUCTION OF HIGHLY STRIPPED HEAVY IONS IN HOT-ELECTRON PLASMAS PRODUCED BY AN ELECTRON BEAM. Alexeff, I.; Jones, W. D. (Oak Ridge National Lab., Tenn.). [1970]. 11p. Dep. NTIS.

From International conference on multiply-charged ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971).

A simple magnetic mirror device was used to produce two groups of ions. A low-Z ion group is produced by direct ionization and has little kinetic energy. The ions are rapidly lost through the mirrors. The second group of ions is formed of fast ions trapped between the magnetic mirrors. These ions are not required to satisfy the demands of particle conservation and ambipolar electric field ejection, and so can remain for long times in the plasma. This group can exist long enough for multiple-electron-impact to become effective. Some experimental results are given. (M.O.W.)

2981 (N-71-28636) EXPERIMENTAL RATE COEFFICIENTS FOR COLLISIONAL EXCITATION OF LITHIUM-LIKE IONS. Kunze, H.-J.; Johnston III, W. D. (Maryland Univ., College Park. Dept. of Physics and Astronomy). [1971]. 32p. (NASA-CR-119017). NTIS.

Collisional excitation rates in N5, O6, and Ne7 were derived from absolute line intensities emitted by these ions in a well-diagnosed plasma. The plasma was produced in a theta-pinch device, and several plasma conditions were investigated. Electron density and temperature were obtained as a function of radius and time from the spectrum of scattered laser light. Although the accuracy of the individual rate coefficients is a factor of 2 only, the rms deviation of the experimental values from the theoretical ones is about 10% for excitation to the n = 2 and n = 3 levels and about 15% for excitation to the 4s level. The rates to the 4p and 4d levels are, on the average, ~60% of the theoretical ones. (auth) (STAR)

2982 (N-71-28637) COLLISIONAL IONIZATION RATES FOR LITHIUM AND BERYLLIUM-LIKE IONS. Kunze, H.-J. (Maryland Univ., College Park. Dept. of Physics and Astronomy). [1971]. 22p. (NASA-CR-119018). NTIS.

Collisional ionization rates for C4, N5, and O6 as well as for O5 and Ne7 are deduced from the time history of spectral lines emitted by these ions in a hot plasma. The plasma (in the elec-

tron temperature range 100 to 260 eV) is produced in a 15-kJ theta-pinch device and is analyzed using the light-scattering technique. The results are consistent with theoretical calculations for O6, and with a semi-empirical formula based on theoretical calculations for hydrogenic ions. (auth) (STAR)

2983 (NP-19059) DESIGN AND CHARACTERISTICS OF A ROTATING PLASMA DEVICE. Bannenberg, Jan Gerard (Technische Hogeschool, Delft (Netherlands)). 6 Oct 1971. 103p. Dep. NTIS (U. S. Sales Only).

The essential feature of a rotating plasma device is that neutral gas is ionized in a configuration with crossed electric and magnetic fields. This method is, in principle, suitable to provide a plasma with a high-temperature ion component and relatively cold electrons. Similar experiments in the world and various reasons for doing research on rotating plasmas are reviewed. After a short review of the earlier experiments on rotating plasmas in this institute, the features of the "Kruisvuur II" device are given, including the diagnostics used. The coils and the capacitor bank used to create the magnetic mirror field are described. A general treatment of coils with a low and/or fractional number of turns is given, followed by the design of the coils used in the experiment. The problems associated with the parallel operation of a large number of switches (ignitrons) necessary to carry the 0.3-MA current for each coil are treated also. The dynamic behavior of a hydrogen puff, released by a fast valve, is studied. This fast valve is an essential element in the rotating-plasma device where, during a transient state, the plasma is bounded by high vacuum rather than by insulating end walls. Attempts were made to determine plasma conditions from external measurements, in contrast to some other work, where deductions were made from internal measurements. Measurements are described for the case where the magnetic field lines end on the metal wall and an internal short develops. The internal crowbar can be located with external wall probes. The plasma energy is measured with diamagnetic loops and compared with theoretical calculations. The internal short is prevented and a rotating plasma is formed that can be braked by applying an external short circuit. Simultaneous diamagnetic measurements with a number of external loops enable the derivation of plasma dimensions, Larmor energy, and rotational energy. In the calculation the induced wall currents are taken into account. The loss of plasma containment leads to a burning voltage proportional to B^2 instead of the linear relation as given by Alfvén. (auth)

2984 EINFUEHRUNG IN DIE PLASMAPHYSIK. I. THEORETISCHE GRUNDLAGEN. (Introduction to Plasma Physics. I. Theoretical Basis). Cap, Ferdinand. Wissenschaftliche Taschenbuecher, Band 72. Berlin; Akademie-Verlag (1970). 214p. 8.- M.

The theoretical principles of plasma physics are presented. The characteristics of a plasma, classification of plasmas, and applications of plasma physics are first discussed. The basic equations for the motion of charged particles in electromagnetic fields, statistical theory, and magnetohydrodynamics are given. Applications of these basic equations to multiliquid theory, Ohm's law and transport phenomena, and special plasma theories are discussed. (J.S.R.)

2985 SPECTRAL AND STRUCTURAL INVESTIGATIONS OF A PULSE DISCHARGE IN OWN MAGNETIC FIELD. Petrakiev, A.; Milanova, R. God., Sofii. Univ., Fiz. Fak.; 63: 107-22(1968-1969).

A pulsed discharge in its own magnetic field was investigated. The dependence of the factor of the magnetic influence on the supply voltage of the discharge, the potential for exciting the spectral lines, and the flowing time of the discharge are investigated. Structural changes of the discharge as a function of the discharge time were studied. (M.O.W.)

2986 RAPID HEATING OF CONDUCTING MATERIALS. (to Geb. Bohler and Co. AG). French Patent 1,568,415. 14 Apr 1969. Priority date 17 Apr 1967, Austria. (In French).

A method and apparatus for the rapid heating of conducting materials are described. The method consists in the ionization of an ionizable gas in a nonhomogeneous alternating field. The plasmoid formed is conducted to the material to be heated. Apparatus for the generation of the plasmoid and its conduction to the material to be heated are described. (J.S.R.)

2987 INITIATION OF A DISCHARGE IN A MEGAVOLT GAS SPARK GAP BY AN ELECTRON BEAM. Abramyan, E. A.; Borob'ev, V. V.; Egorov, A. A.; Elkin, V. A.; Ponomarenko, A. G. (Inst. of Nuclear Physics, Novosibirsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 130-1(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 117-18(Jan-Feb 1971).

The preliminary results of experiments on the excitation of a discharge in a gas spark gap under high pressure by means of external injection of an electron beam are presented. The study of nanosecond commutation of megavolt gaps is designed for plasma research, work in the field of accelerators, and work in nanosecond engineering. (auth)

2988 PRODUCTION OF POPULATION INVERSIONS BY INJECTING NEON INTO AN ARC-HEATED RAPIDLY EXPANDING HELIUM PLASMA. Dalton, James Verne. Houston, Tex.; Rice Univ. (1971). 69p. University Microfilms Order No. 71-26,279. Thesis.

Recent analytical studies have indicated that fluid-mechanical experimental techniques can be adapted to the production of population inversions of the type present in conventional gas lasers such as the helium–neon laser. An arc-heated plasma jet facility was used to separate the excitation of helium in the electric arc discharge from the excitation of neon by resonant energy-transfer collisions with the helium metastable atoms. In this manner, the neon is excited primarily by helium metastables away from the electric arc discharge so that only the Ne (3s) and (2s) energy levels are collisionally excited. The lower energy levels are populated by radiative decay from the Ne (3s) and Ne (2s) levels. The excited helium gas produced in the arc chamber exhausted as a free jet through a converging nozzle into a low-pressure test section. At several stations downstream of the nozzle exit, neon was injected into the free jet through a ring-type manifold. The spectral line intensities emitted by the decaying helium and neon atoms were measured at several stations downstream of the nozzle exit. The measured spectral line intensities yield the population density of the upper level of the radiative transition. The results indicate that the maximum population inversion of the Ne ($3s_2$) energy level relative to the Ne ($3p_4$) energy level occurred about one-half inch downstream of the nozzle exit for neon injection at one-eighth inch downstream of the nozzle exit. At this location the electron temperature of the expanding helium plasma, assuming Boltzmann equilibrium of the upper excited energy levels at the electron temperature, was calculated to be about 3570°K and the free electron density was calculated to be about 1.7×10^{14} cm^{-3}. For the maximum population inversion the gain per unit length was calculated to be 2×10^{-3} cm^{-1}. The results measured justify the use of a fast flow system to produce population inversions of the type present in conventional gas lasers. (Diss. Abstr. Int., B)

2989 DETERMINATION OF THE PARAMETERS β_l AND l_i IN A TOKAMAK FOR ARBITRARY SHAPE OF PLASMA PINCH CROSS SECTION. Shafranov, V. D. (Inst. of Atomic Energy, Moscow). Plasma Phys.; 13: No. 9, 757-62(Sep 1971).

The pressure balance equation and relation between the measured external magnetic field of a toroidal plasma column and its inductance are found for the general case of an arbitrary departure from cylindrical symmetry. (auth)(UK)

2990 EXPERIMENTAL EVIDENCE OF ELEMENT AND ISOTOPE SEPARATION IN A ROTATING PLASMA. Bonnevier, Bjoern (Royal Inst. of Tech., Stockholm). Plasma Phys.: 13: No. 9, 763-74(Sep 1971).

It has earlier been suggested by the author that the strong centripetal acceleration in a rotating plasma, typically of the order 5×10^{10} m/sec^2, can be used for separating different species of elements and isotopes. Results of an experimental investigation of separation effects in a rotating plasma and a method for collecting separated plasma are presented. The main diagnostic technique is mass spectrometry. (auth)(UK)

Kinetics (Experimental)

2991 (JINR-P9-5853) HIGH-FREQUENCY DISCHARGE IN A COAXIAL RESONATOR WITH AN EXTERNAL MAGNETIC FIELD. Ivanov, G. A.; Gavrilova, E. G. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1971. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

Conditions for the development of single-electrode high-frequency discharges are investigated. For specific loss stipulations resulting from the discharges, the magnitude and control of the fundamental secondary emission coefficients and frequency ratio (ω_0/ω) are shown, where $\omega_0 = (eH/mc)$ and ω is the angular velocity of hf fields. (tr-auth)

2992 (NP-19058) MEASUREMENTS OF ELECTRON VELOCITY DISTRIBUTION FUNCTIONS IN FRONT OF AND BEHIND A PLASMA SHEATH. Andersson, Dag (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Sep 1970. 49p. Dep. NTIS (U. S. Sales Only).

The velocity distribution of electrons around a plasma sheath obtained at a constriction of a mercury discharge tube was studied. Different combinations of current and pressure were investigated. It is shown that the distribution function of the magnitude of velocity is rather Maxwellian in front of the sheet, while it seems to be a sum of a Maxwellian part and a "beam" distribution behind it. (Sweden)

2993 (NP-19075) STARK EFFECT IN A TURBULENT PLASMA OF R.F. DISCHARGE IN "OMEGA" DEVICE. Berezin, A. B.; Dubovoi, L. V.; Lublin, B. V. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1970. 7p. Dep. NTIS (U. S. Sales Only).

Profiles of Hα, Hβ and Hγ spectral lines in a plasma of a powerful hf discharge were measured. In conditions when ion-sound instability takes place, abnormally large broadening of Hβ and Hγ lines is found for a perpendicular direction to the hf discharge. The strength of the longitudinal component of the microturbulence field $\tilde{E}_{\parallel} \parallel E_{\omega}$ is evaluated. In experiments with $E_{\parallel} \gtrsim 1$ keV/cm, strong anisotropy of the turbulence field, corresponding to $E_{\parallel} \gg E_{\perp}$ is found. (auth)

2994 SLOW TOROIDAL θ-Z-PINCH EXPERIMENT. Bowers, D. L.; Liley, B. S.; Morton, A. H.; Vance, C. F. (Australian National Univ., Canberra). Plasma Phys.; 13: No. 9, 849-83(Sep 1971).

A slow (1.6 ms to peak current) toroidal θ-Z pinch is described, interest being centered on "transitions" between stable and unstable states. Provided the electron temperature is above a certain critical value (~3.5×10^5 °K), the behavior is little different from that of a Tokamak operating in its so-called unstable mode. The discharge goes through repeated instability cycles (~400 μs period) of oscillatory, contraction and expansion phases. The electrons are heated (to several hundred eV max) during the contraction phase and cooled during the expansion phase. Ions are accelerated (to perhaps several keV) during the expansion phase and either lost or "cooled" during the oscillatory phase. With emphasis on the instability cycle, the basic measurements and distributions are described. An approximation for the magnetic surfaces is obtained, electron and "ion" temperatures as functions of time are determined, and particle and energy containment times τ_p and τ_e are deduced. The overall hydromagnetic stability is shown to be consistent with the Kruskal-Shafranov limit. Both τ_p and τ_e are ~1 ms prior to the onset of a voltage spike. The mean value of τ_p is ~2 ms, but the mean value of τ_e is only ~100 μs. (auth)(UK)

Kinetics (Theoretical)

2995 (CEA-N-1463) EVOLUTION OF PLASMA IN TOKAMAK-TYPE CONFIGURATION. Bayard, Jean-Paul; Boujot, Jean-Paul; Soule, Jean-Louis (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1971. 47p. (In French). Dep. NTIS (U. S. Sales Only).

A numerical program used for simulating a Tokamak experiment is described. The toroidal effect is neglected and the plasma hydrodynamics are described using an MHD system deduced from the BBGKY system; a one-fluid model with cylindrical geometry is then introduced. The choice of this mathematical model is discussed. An analytical treatment is given for a simplified case. (France)

2996 (COO-2059-8) QUASILINEAR THEORY, REVISED AND TESTED. Burns, Thomas; Knorr, Georg (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jul 1971. Contract AT(11-1)-2059. 52p. Dep. NTIS.

The quasi-linear theory is revised analytically and its consequences are tested by a numerical simulation for a one-dimensional periodic electron plasma with discrete electrostatic modes. The theory is formulated for unstable and damped modes. The numerical model is a Vlasov-Poisson system where the mode-mode coupling terms have been omitted. The result is that the predictions of the analytical theory are confirmed by simulation. For all cases considered there are always several modes that are initially unstable, but become damped at a later time so that an inclusion of damped modes in the theory is absolutely necessary. (auth)

2997 (JUL-760-MA) SOLUTION OF THE LINEARIZED VLASOV EQUATION WITH PERIODIC BOUNDARY CONDITIONS. Profant, Miroslav; Wick, Joachim (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Angewandte Mathematik). May 1971. 26p. (In German). Dep. NTIS (U. S. Sales Only).

The problem of the linearized Vlasov equation is formulated, its treatment with transformation methods is presented, its numerical evaluation is given, and a new method for its solution is outlined. A Maxwell distribution is assumed as equilibrium distribution. Superimposed upon the distribution is a periodical spatial disturbance in the form of a cosine function. With these initial conditions, relatively low values for electrical energy are obtained. (H.B.G.)

2998 (N-71-28173) PARTITION FUNCTIONS AND EQUATIONS OF STATE IN PLASMAS. Sparks, W. M.; Fischel, D. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). 1971. 617p. (NASA-SP-3066). NTIS.

Theoretical gas characteristics of plasmas of seven different chemical compositions were calculated and are presented in tabular form. The seven cases are six pure gases (H, He, N, O, Ne, and Ar) and the solar chemical composition. All data are tabulated for 10 electron pressures from 0.01 to 10^6 dyne/cm^2 and for 50 temperatures from 3000 to 150,000 K. The tables include electron density, particle density, number of free electrons per atom, number of negative hydrogen ions per hydrogen atom, mass density, gas pressure, equation of state parameter, degeneracy parameter, ionization energy per gram, ionization plus excitation energy per gram, total energy per gram, partition functions, ionization fractions, and depression of the ionization potentials. (auth) (STAR)

2999 INITIAL PARTICLE DISTRIBUTIONS FOR SIMULATED PLASMA. Williamson, J. H. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Comput. Phys.; 8: No. 2, 258-67(Oct 1971).

A simple method is proposed for distributing charged particles in space so that they have a thermal energy spectrum. The ions and electrons are taken in pairs placed randomly over the mesh, but the relative position within each pair is chosen to fit the Debye distribution. Hardly any more time is needed to set up the particles properly in this way than is needed for purely random positioning. (auth)

3000 STATISTICAL HYDRODYNAMICS OF PLASMAS. Kim, S. H.; Wilhelm, H. E. (Colorado State Univ., Fort Collins). Phys. Rev., A; 4: No. 6, 2308-14(Dec 1971).

A canonical theory is developed for a collisionless plasma in which the electrons interact with quasi-stationary ions by the self-consistent electric field. The nonlinear equations of motion of the electron fluid and continuity for the electric current density are obtained as functional derivatives of the Hamiltonian of the plasma with respect to the canonical conjugate fields (which are proportional to the mean mass velocity and electric field, respectively). By means of a Fourier analysis, it is shown that Hamiltonian equations exist for the complex Fourier amplitudes of the canonical-conjugate fields, which correspond to the Fourier transforms of the nonlinear Eulerian equations of motion and continuity of the electron gas. The Liouville equation is derived for the distribution function in the multidimensional phase space formed by the complex Fourier amplitudes of the canonical-conjugate fields. A statistical definition of the entropy contained in the wave modes is given in form of an integral functional of the phase-space density. The theoretical considerations indicate a quasi-particle behavior of the wave modes of the classical plasma continuum. (auth)

3001 VALIDITY OF THE QUASI-STEADY STATE AND COLLISIONAL-RADIATIVE RECOMBINATION FOR HELIUM PLASMAS. I. PURE AFTERGLOWS. Limbaugh, C. C. (Arnold Engineering Development Center, Arnold Air Force Station, Tenn.); Mason, A. A. Phys. Rev., A; 4: No. 6, 2368-77(Dec 1971).

The set of differential equations describing the time-dependent decay of a singly ionized optically thin monatomic gas was solved numerically for constant-temperature-constant-pressure helium afterglows. In the range of conditions studied ($6000 \leq T_e \leq 14{,}000$°K, $1.5 \times 10^{12} \leq n_e \leq 5.38 \times 10^{15}$ cm^{-3}, $1.5 \times 10^{14} \leq n_0 \leq 1.63 \times 10^{17}$ cm^{-3}) it was found that collisional-radiative recombination can be applied to the electron-density decay before the plasma reaches the quasi-steady state. The initial condition for each plasma studied was a Boltzmann distribution from the $2\,^3S$ state throughout the higher states. The mechanism by which the quasi-steady state is obtained is examined and the transient coupling between states is illustrated. Times for the plasma to reach the quasisteady state ranged from $t \approx 10^{-8}$ sec for high-density plasmas to $t \approx 10^{-4}$ sec for low-density plasmas. (auth)

3002 GREEN'S FUNCTION FORMULATION OF SPECTRAL LINE BROADENING IN PLASMAS. Lee, Richard William. Gainesville, Fla.; Univ. of Florida (1970). 172p. University Microfilms Order No. 71-24,431. Thesis.

Three Green's function theories of spectral line broadening in plasmas are presented. These theories use three different techniques: a graphical technique, a truncation of the Green's function hierarchy, and a functional derivative expansion to calculate the line shape function. A derivation that outlines the approximations needed to arrive at the usual expression for the line shape in the static-ion limit is given. The primary broadening mechanism considered in this derivation is the Stark interaction between the radiating atom and the electric field produced by the ions and electrons in the surrounding plasma. The line shape function is then related to the two-particle Green's function. Next, the Green's function techniques are used to calculate the line shape function. These techniques reduce the problem of calculating the line shape function to the determination of a two-particle self-energy operator. This self-energy operator corresponds to the shift and width operators found in previous theories. The graphical technique used produces a result similar to that of Ross and Zaidii, while the results of the truncation method are comparable to the findings of Klein and Nishikawa. The functional derivative expansion is then used to derive an equation for the self-energy operator, which is a functional of the coupling constant and the two-particle Green's functions. This use of the functional derivative technique is an extension of the method given by Kadanoff and Baym for the one-particle Green's function. A comparison is then made with the impact theories of Baranger and Griem, and also the projection operator technique employed by Smith and Hooper. (Diss. Abstr. Int., B)

3003 ENERGY LOSS OF A FAST ION IN A PLASMA. Gould, R. J. (Univ. of California, San Diego, La Jolla). Phys. Lett.; 36A: No. 6, 485-6(11 Oct 1971).

An exact expression is given for the stopping power of a plasma for a fast, but nonrelativistic, test ion. The general formula, which yields the classical result in the low-energy limit and the Born-approximation formula at high energies, is found essentially by identifying the essential aspects of the formulation of this problem with those of the problem of low-frequency Coulomb bremsstrahlung. (auth)

3004 SOME ATOMIC PROCESSES IN LOW-DENSITY PLASMAS. Thakur, Ratna Kumar. San Diego, Calif.; Univ. of California (1971). 143p. University Microfilms Order No. 71-24,131.

Thesis.

For a partially ionized hydrogen–helium plasma at 10^4 to 10^6°K the processes bremsstrahlung, radiative and dielectronic recombination, excitation of discrete levels, and collisional ionization due to electron collisions with various species are discussed. The steady-state ionization conditions are computed, assuming a balance between collisional ionization and radiative and dielectronic recombination; this is done for the cases where the plasma is optically thin and optically thick to photons resulting from radiative captures to the ground states of the recombined species. The cooling rates for the plasma are computed for all of the above processes. A brief discussion is given of the effects of deviation from a Maxwellian electron velocity distribution. Possible applications of the result in astrophysics are mentioned, the principal application being to the primordial gas after decoupling of the matter from the radiation. (TSS) (Diss. Abstr. Int., B)

3005 FLOW OF A PLASMA AROUND A DISK IN A MAGNETIC FIELD. Waldes, John. New York; Columbia Univ. (1971). 94p. University Microfilms Order No. 71-23,635.

Thesis.

Density perturbations behind an electrically floating disk located in a column of low-density flowing plasma were studied. The problem was studied numerically using the Vlasov equation and uniform plasma distribution as developed by Al'pert (1965). Computer solutions were carried out exactly for the experimental flow velocities with thermal effects in the longitudinal direction included. Plasma density profiles were modeled in the calculation allowing comparison of experimental data taken with nonuniform density. The experiment was conducted in a potassium Q machine with a longitudinal magnetic field. The flow velocity was 2 to 4 times the thermal velocity, and the ratio of the radius of the body to the ion Larmor radius was ~1. Density measurements were made in the near and far wake using Langmuir double probes. The theory satisfactorily describes the far wake of the disk and the density pulsations that immediately follow it. However, it is necessary to consider electric fields due to the density gradients to explain other aspects of the wake structure just behind the disk. (Diss. Abstr. Int., B)

3006 STUDY OF ELECTRODYNAMICS OF MOVING SOURCES IN A GYROMAGNETIC PLASMA. Kim, Young Cho. Seattle, Wash.; Univ. of Washington (1971). 112p. University Microfilms Order No. 71-24,048.

Thesis.

Evaluation of electromagnetic fields moving in a magnetoplasma with a constant velocity is complex due to the fact that the interaction between fields and magnetoplasma is described by tensor parameters instead of conventional scalar parameters. Furthermore, cross-coupling between electric and magnetic fields results from the relativistic movement. Because of these reasons, studies in this field so far tend to be restricted to rather simple cases where either the relative velocity is very small or the external constant magnetic field is oriented parallel or perpendicular to the direction of movement. This paper is an attempt to formulate the problem with arbitrarily oriented constant magnetic field and relative movement. (TSS) (Diss. Abstr. Int., B)

3007 BEHAVIOR OF A MAGNETIZED PLASMA IN A TRANSVERSE QUADRUPOLE ELECTRIC FIELD OSCILLATING NEAR ION CYCLOTRON RESONANCE. Walters, Craig Thompson. Columbus, Ohio; Ohio State Univ. (1971). 123p. University Microfilms Order No. 71-27,579.

Thesis.

A theoretical study of the response of a fully ionized magnetized plasma to the transverse field of a quadrupole generating structure was conducted. The externally applied magnetic field was assumed to be uniform and constant in time, and the quadrupole-field generating structure provided a purely transverse electrostatic field oscillating near ion-cyclotron resonance. Single-particle ion trajectories were studied in detail in the absence of plasma-generated fields. Results are reported for variations of the electric field strength, electrode geometry, and off-resonance parameters. The most significant results include the ability to accelerate ions to high energies while maintaining containment for a wide range of the parameters and the ability to simultaneously and optimally excite deuterons and tritons with a mixed frequency field. Particle collections were also examined in the study to assess macroscopic effects. It was found that plasma-generated magnetic fields provide a means for phase mixing the ions and, therefore, the space-charge-generated electric fields are reduced significantly. Calculations indicate that a dense central core of hot plasma is formed and that, for reasonable system parameters, a favorable fusion power balance is possible. (Diss. Abstr. Int., B)

3008 SPECTRAL ANALYSIS OF LINEARIZED BALESCU–LENARD KINETIC EQUATION WITH APPLICATIONS TO DIFFUSION IN VELOCITY SPACE AND TO THE RESPONSE OF A PLASMA TO THE ABSORPTION OF IONS BY NUCLEAR REACTIONS. Merchant, Allan Henry. Ithaca, N. Y.; Cornell Univ. (1971). 262p. University Microfilms Order No. 71-27,389.

Thesis.

The Balescu–Lenard equation, which is relevant for a high-temperature fully ionized plasma and which embodies the effect of the dynamic dielectric screening of the particles, is studied theoretically and applied to some physical problems. The equation is linearized about a Maxwellian distribution, and the spectral properties of the resulting linear operator are studied in detail. It is found that the spectrum forms a continuum from zero eigenvalue to minus infinity and has no point component except for the zero eigenvalue. Analytic and numerical methods for approximating the eigenfunctions are developed. This linear theory is then applied to the problem of the diffusion in velocity space of an initially sharply peaked distribution. The very-long-time behavior of the velocity distribution function relevant to the diffusion problem is analyzed. Next, a study is made of the response of the proton distribution of a hydrogen plasma to the introduction of heavy ions that absorb protons by nuclear reactions. This study is carried out both in the linear and nonlinear regimes, the latter study being based on certain approximations that are valid if the nuclear reaction rate is much greater than the plasma collision frequency. The temperature change and the work done by an applied electric field on transient currents caused by the absorption process is calculated. (Diss. Abstr. Int., B)

3009 ENERGY DISTRIBUTION OF IONS SLOWING DOWN IN A PLASMA. Adler, F. T.; Dorning, J. J. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc.; 14: No. 2, 446-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3010 FLOW OF A PLASMA AROUND A DISK IN A MAGNETIC FIELD. Waldes, J.; Marshall, T. C. (Columbia Univ., New York). Plasma Phys.; 13: No. 9, 837-47(Sep 1971).

Density perturbations behind an electrically floating disk located in a column of low-density flowing plasma were studied. The problem was studied numerically using the Vlasov equation and uniform

plasma distribution as developed by AL'PERT (1965). Computer solutions were carried out exactly for the experimental flow velocities with thermal effects in the longitudinal directional included. Plasma density profiles were modeled in the calculation allowing comparison of experimental data taken with nonuniform density. The experiment was conducted in a potassium Q machine with a longitudinal magnetic field. The flow velocity was 2 to 4 times the thermal velocity and the ratio of the radius of the body to the ion Larmor radius was ~1. Density measurements were made in the near and far wake using Langmuir double probes. The theory satisfactorily describes the far wake of the disk and the density pulsations that immediately follow it. (auth)(UK)

3011 RAYLEIGH'S PROBLEM IN COLLISIONLESS PLASMAS. Chang, T. S.; Chang, C. M. (North Carolina State Univ., Raleigh). Plasma Phys.; 13: No. 9, 695-714(Sep 1971).

The initial motion of the unsteady plasma boundary layer flow over an infinite flat plate with heat transfer effects under the influence of an applied magnetic field is studied. Based on a plasma kinetic formulation, small-time exact solutions are derived for the linearized Rayleigh's problem in plasmas consisting of collisionless electrons embedded in immobile ions. Detailed discussions are presented concerning the time-dependent distributions of a number of interesting plasma flow properties, such as number density, velocity component in the direction of plate motion, velocity slip at the plate, and skin friction coefficient. The present method of solution seems to be applicable to a large class of plasma boundary-layer flow problems in which the interactions between moving plasmas and solid surfaces are important. (auth)(UK)

3012 SPECTRA AND CORRELATION FUNCTIONS FOR ION SOUND TURBULENCE. Tsytovich, V. N. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Plasma Phys.; 13: No. 9, 741-56(Sep 1971).

A theory is given for the spectra and correlation functions for ion sound turbulence. It is shown that the correlation time can be short enough to affect appreciably the nonlinear interactions. The actual value of the anomalous resistivity for plasma in an external electric field is calculated. The ion sound spectra resulting from the nonlinear conversion is discussed. (auth)(UK)

Production

3013 CATHODE FOR DUOPLASMATRON-TYPE ION SOURCE. Hall, Robert R. (to United States Atomic Energy Commission). U. S. Patent 3,602,763. 31 Aug 1971. Filed 28 Oct 1969.

A central spike cathode is added to and is axially positioned through the conventional spiral-filament-type cathode of a duoplasmatron-type ion source such that the current output and cathode lifetime thereof are substantially increased. The added spike cathode is so positioned that it is the closest item to the intermediate electrode of the ion source. Further increase in operating performance can be obtained when a cylindrical shield is utilized to surround the cathode assembly. The spiral filament may be turned off after initiating the arc of the ion source. (auth)

3014 FORMATION AND COLLISION OF LASER-PRODUCED CARBON PLASMAS. Dingee, David Aaron. Columbus, Ohio; Ohio State Univ. (1971). 139p. University Microfilms Order No. 71-22,465.

Thesis.

An experimental study was conducted using nominal 0.5-joule neodymium-glass lasers having 40- and 70-nsec pulse widths incident on bulk carbon and carbon foils in vacuum. Quantitative measurements of the line spectrum in the visible and near-ultraviolet show that ions C I through C IV are present in the plasma produced with the laser focused to about 4×10^{10} w/cm^2 on the bulk carbon. Electron temperatures near 1 eV were measured by C II line ratios and densities of 10^{17} cm^{-3} at 0.5 cm from the carbon block were measured by Stark broadening. Ion streaming velocities of 5.5×10^6 cm/sec for C II and 2×10^7 cm/sec for C IV were also measured by the time-of-flight technique in the range 0.5 to 1 cm from the target. These ion and electron quantities are in reasonably good agreement with a gas-dynamic model of the absorbing and expanding plasma. Carbon foils of 500 and 2000 Å thickness were exposed to the same laser light intensity. The foils proved to absorb only a small fraction of the light, however there is a plasma formed that is nearly symmetric toward and away from the incident laser direction. The foil behavior is also consistent with the free-free absorption model for laser light and gas-dynamic expansion. The interpenetration of two identical plasmas was studied with the result that there is a collision effect. Heating occurs in a collision zone with the temperature rising only a few eV, along with a fluid-like interaction that stagnates the plasma collision event for times near 200 nsec. The collision is characterized by Coulomb interactions and analysis of ion-electron interactions suggests these are important in describing the event. (Diss. Abstr. Int., B)

Stability

Refer also to abstract 3043.

3015 (COO-2059-7) NONLINEAR EVOLUTION OF THE DORY-GUEST-HARRIS INSTABILITY. Joyce, Glenn; Knorr, Georg (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). May 1971. Contract AT(11-1)-2059. 30p. Dep. NTIS.

The nonlinear evolution of the Dory-Guest-Harris type instability is investigated by numerical integration of the Vlasov equation in one-spatial and two-velocity dimensions. Two methods are used: a particle simulation and the Fourier-Hermite transform. The two methods are compared for $f_0(v_\perp) = (2\pi 5')^{-1} (v_\perp/\sqrt{2})^{10} \exp(-v_\perp^2/2)$ for k values that are unstable. A method of predicting the limiting amplitude of the electric field is presented for the case in which one mode dominates the system. (auth)

3016 MAGNETIC AND GRAVITATIONAL ENERGY RELEASE BY RESISTIVE INSTABILITIES. Cross, Mark A.; Van Hoven, Gerard (Univ. of California, Irvine). Phys. Rev., A; 4: No. 6, 2347-53(Dec 1971).

The resistive magnetohydrodynamic "tearing" and "gravitational-interchange" instabilities are investigated in the linear incompressible limit in the absence of heating. A periodic model is used for the initial magnetic field. The requirement that the spatial Fourier series of the perturbation must converge uniquely determines the growth rate of the instability. At the most unstable wavelength the tearing mode has a growth rate $\omega\tau_r = 3.4S^{0.57}$, where S is the magnetic Reynolds number at the Alfvén velocity and τ_r is the resistive diffusion time. The interchange mode exhibits behavior, at small wavelengths and large gravitational fields, similar to that of the magnetohydrodynamic Rayleigh-Taylor instability. The resistive mode grows for gravitational fields smaller than the equivalent Suydam threshold for infinite-conductivity instability in a sheared magnetic field. Application of these results to the solar-flare problem is briefly discussed in the context of the temporal behavior exhibited. (auth)

3017 INSTABILITIES OF A CURRENT-FREE DISCHARGE IN A MAGNETIC FIELD. Shvilkin, B. N.; Postnikov, S. A. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 15: No. 12, 2349-51(Dec 1970).

The limits of the ion shock and drift instabilities were studied experimentally and compared with theory. Measurements were made in He, Ar, and Kr within the range of pressures 2×10^{-2} to 10^{-3} mm Hg. Signals were detected by probes placed around the discharge chamber. Two types of oscillations observed are discussed. (M.O.W.)

3018 NUMERICAL EXPERIMENTS OF TWO-STREAM INSTABILITIES IN ONE-DIMENSIONAL FINITE-LENGTH SYSTEMS. Lin, Anthony Tung-hsu. Ann Arbor, Mich.; Univ. of Michigan (1970). 198p. University Microfilms Order No. 71-23,806.

Thesis.

The two-stream instability in one-dimensional finite-length systems is studied by computer-simulation methods in which charges are represented by discrete charge sheets with specified surface charge density and infinitesimal thickness. The system is situated in an idealized "square-well" mirror magnetic field with a mirror ratio such that, at the ends of the interaction region, all beam sheets are lost and all plasma charge sheets are reflected back into the system. The motions of charged sheets in the system in the presence of their self-consistent electric fields are followed in time. Throughout the computer experiment the trajectory data are analyzed, and the significant system microscopic and macroscopic variables are calculated to assess the detailed behavior of the instability. The results calculated for the beam-plasma instability using the two-component plasma model demonstrate that an increase in the inhomogeneity of the plasma density distribution does reduce the spatial growth rate of the dominant mode in the beam-plasma interaction. It is observed that the beam-plasma instability decays when the intensity of the instability exceeds some threshold level. This decay phenomenon is associated with the excitation of large-amplitude ion-density fluctuations. It is believed that the ion beam-plasma interaction is more useful in the process of plasma heating due to its heavier mass, which yields a large-energy source, a low rate of decrease of the mean ion-beam speed, and a slower thermal

spreading of the ion-beam velocity in comparison with the interaction between an electron beam and a similar plasma. (Diss. Abstr. Int., B)

3019 DRIFT-DISSIPATIVE INSTABILITY. Sleeper, Arthur Michael. Rochester, N. Y.; Univ. of Rochester (1971). 124p. University Microfilms Order No. 71-22,321.

Thesis.

The drift-dissipative instability may occur in a weakly ionized inhomogeneous plasma immersed in a magnetic field, and it is driven solely by the presence of the density gradient. The general behavior of the instability in the neighborhood of the critical point at which instability onsets is studied. After obtaining a suitable equilibrium, basic equations are linearized for small perturbations about this equilibrium. The solution of these linear equations leads to a dispersion relation for the frequency. The dispersion relation is examined to obtain the conditions on the parameters such that the imaginary part of the frequency is positive, leading to growth of the perturbation. Analysis of the dispersion relation yields analytic expressions for the criterion for instability onset and all other critical linear parameters. It is found that by suitably specifying a region of parameter space (background pressure and magnetic field) a single (degenerate) mode will go unstable as the pressure is reduced below a critical value. One assumes that, as this mode grows nonlinear, effects will occur which limit the growth rate. After a sufficiently long time a new equilibrium will be reached that will now include the finite-amplitude mode. The final amplitude of the mode is assumed to be a continuous function of the (small) fractional decrease of the pressure below the critical value, and it is further assumed that it goes to zero as the pressure is increased toward the critical point. The mode amplitudes, frequency shift, and anomalous flux are calculated to first order in the fractional decrease in pressure. One finds that the frequency shift is very small for this instability. Mode coupling is shown to be negligible. The calculations were performed in idealized slab geometry in which the plasma is created continuously at one plate and absorbed at the other. The method is extended to coaxial geometry in which the plasma is created at the inner cylinder and absorbed at the outer and to true cylindrical geometry in which the plasma is either created at a fixed rate at end plates (Q machine) or by an rf field. The qualitative features of the instability (onset criterion, small frequency shift and flattening of the initial density gradient) are similar for all of the geometries and plasma-production processes studied. (Diss. Abstr. Int., B)

3020 CURRENT-DRIVEN COLLISIONAL DRIFT INSTABILIN A THERMALLY IONIZED CESIUM PLASMA. Ellis, Richard Frederick. Princeton, N. J.; Princeton Univ. (1971). 129p. University Microfilms Order No. 71-23,355.

Thesis.

Experimental and theoretical studies were made of the current-driven collisional drift instability. This very strong [$\mathrm{Im}(\omega) \sim \mathrm{Re}(\omega)$], low-frequency ($\omega \ll \Omega_i$) instability was observed in a collision-dominated double-ended Q-machine cesium plasma ($n_0 = 10^{10}$ to 3×10^{11} cm^{-3}, $T_e \simeq T_i \simeq 0.2$ eV) with axial currents such that the electron drift speed varied from 1 to 15% of $(kT_e/m_e)^{1/2}$. Positive instability identification is based on a detailed comparison of experimental wave parameters with a linearized two-fluid theory. This theory includes the effects of electron heat flow, electron temperature fluctuations, parallel resistivity, finite ion Larmor radius, and transverse ion viscosity. A dispersion relation is derived for waves traveling in the direction of electron flow; exact axial normal modes are calculated for the Q-machine geometry in the limit of small currents. Theory and experiment are in agreement on: 1) the strong destabilizing effect of axial current; 2) magnitude of the frequency and its parametric dependence on magnetic field, azimuthal mode number, and axial current; 3) qualitative features of the axial structure and their variation with axial current; 4) magnitude of the critical current for excitation and its variation with magnetic field and density; 5) relative stability of the different azimuthal modes; 6) variation with current, magnetic field, and density of the relations between fluctuating density and fluctuating floating potential; and 7) variation of growth rate with axial current and magnetic field. In addition, large wave-induced plasma losses occurred with instability onset, and these losses could be explained as the basis of the measured wave parameters as interpreted by the linear theory. Pertaining to the above features, it is stressed that inclusion in the theory of electron heat flow and electron temperature fluctuations is imperative. Finally, no anomalous resistivity was observed that could be attributed to this instability. (Diss. Abstr. Int., B)

3021 LOW-FREQUENCY STABILITY THEORY IN AXISYMMETRIC TORUS WITH SHEAR. Jamin, Eric. Princeton, N. J.; Princeton Univ. (1971). 120p. University Microfilms Order No. 71-25,944.

Thesis.

A study of low-frequency modes in a low-β collisionless plasma, using a multiple scale expansion of the Vlasov equation in a general magnetic geometry, is presented. The analysis is carried out for an axisymmetric toroidal configuration with shear (tokamak like). Flute and trapped-particle modes are considered. Curvature-driven flute modes are analyzed in the three limits of the frequency compared to the electron and ion "bounce" frequencies. The generalized average curvature can be favorable or unfavorable, depending on the direction of the shearing of the lines of force. In both cases the ion flute mode is found to be stabilized by a small amount of shear. Residual instabilities persist, due to wave–particle resonances; their growth rates are evaluated and the stabilizing effect of temperature gradients shown. No radially localized electron flute mode exists for sufficiently large shear. In the highest frequency limit, results of fluid theory are recovered. The case of locally vanishing shear is also analyzed. Trapped-particle instabilities are analyzed, including banana excursions and finite ω/ω_t effects. Stability criteria in the asymptotic limit of small inverse aspect ratio are given for different values of $k_\perp$. The drift trapped-particle mode is typically stable. The stabilizing effect of circulating ions on trapped-particle modes for long parallel wavelengths is shown. (Diss. Abstr. Int., B)

3022 DRIFT INSTABILITIES IN A MULTICOMPONENT PLASMA IN THE PRESENCE OF A LOW-IMPEDANCE ELECTROMAGNETIC FIELD. Teichmann, J. (International Centre for Theoretical Physics, Trieste, Italy). Plasma Phys.; 13: No. 9, 775-84(Sep 1971).

The stabilization of drift modes occurring in a plasma with several kinds of different masses and temperatures (such as impurity ions or trapped particles in curved magnetic field configurations) is studied. The possibility of the reduction of growth rates by applying an electromagnetic hf field with a dominant magnetic component is discussed. (auth)(UK)

3023 TRANSPORT EQUATIONS AND GRADIENT INSTABILITIES IN A HIGH-PRESSURE COLLISIONAL PLASMA. Mikhailovskii, A. B.; Tsypin, V. S. (Inst. of Atomic Energy, Moscow). Plasma Phys.; 13: No. 9, 785-98(Sep 1971).

A theoretical study is presented of the instability of plasma with finite ratio of particle to magnetic pressures. The instabilities caused by spatial gradients are considered. They have a characteristic frequency $\omega \simeq (\rho_i/a)^2\omega_B$ where $\rho_i = v_{T_i}/\omega_{B_i}$ is the ion Larmor radius, $v_{T_i} = T_i/m_i$ is the ion thermal velocity, a is the scale length of the plasma inhomogeneity, $\omega_{B_i} = e_iB_c/m_ic$ is the ion cyclotron frequency. It is shown that the usual set of transport equations for plasma obtained by the Chapman–Enskog method are, broadly speaking, not suitable for investigating instabilities with frequencies of order $(\rho_i/a)^2\omega_{B_i}$. A new system of transport equations applicable to this frequency range is obtained. Some new types of instabilities of finite-pressure plasma are investigated by means of these transport equations. (auth)(UK)

3024 STUDY OF SHORT-WAVELENGTH INSTABILITIES IN THE CONFINEMENT OF A COLLISION-DOMINATED PLASMA BY A ROTATING MAGNETIC FIELD. Troyon, F. (Centre de Recherches en Physique des Plasmas, Lausanne, Switzerland). Plasma Phys.; 13: No. 9, 715-24(Sep 1971).

A collision-dominated plasma confined by a rotating magnetic field is stable if $f \gtrsim 0.02\,\nu_i$ where f is the frequency of rotation and ν_i the ion collision frequency. Short-wavelength perturbations are the most difficult ones to stabilize. Growth rates of parametric instabilities are shown to be so large as to make impossible any attempt to use a frequency much lower than the above limit. A simple interpretation of a wide region of instability, which cannot be ascribed to any parametric instability, is given in terms of an equivalent negative resistance. (auth)(UK)

3025 PLASMA-SHEAR FLOW INSTABILITY WITH ION–ION COLLISIONS. Bhadra, Dilip K. (Gulf General Atomic Inc., San Diego, Calif.). Plasma Phys.; 13: No. 9, 731-40(Sep 1971).

It has been found that instabilities may exist due to shear flow in a plasma and these presumably may lead to a convection cell. The effect of ion–ion collisions on the shear-flow instability in an inhomogeneous plasma using the Bhatnagar, Gross and Krook model for collisions is considered. It is found that, in the limits of the present calculation, the collisions give rise to both stabilizing and destabilizing effects, the contribution from the latter being of lesser importance. (auth)(UK)

3026 COLLISIONAL DRIFT-TYPE INSTABILITY OF A WEAKLY IONIZED MAGNETO-PLASMA WITH NO AXIAL DRIFT. Powers, E. J.; Mumola, P. B. (Univ. of Texas, Austin). Plasma Phys.; 13: No. 9, 817-35(Sep 1971).

The results of a theoretical and experimental study of the stability of inhomogeneous weakly ionized magnetoplasmas with no axial drift are reported. The study is carried out in the regime where $(\Omega\tau)_e > 1$ and $(\Omega\tau)_i \ll 1$. A linearized two-fluid hydrodynamic stability analysis yields a dispersion relation, which is analyzed numerically. Oscillations with an azimuthal phase velocity approximately equal to the electron diamagnetic drift are predicted to become unstable (onset) once the external magnetic field exceeds some critical value. Stability criteria are displayed graphically in terms of the magnetic field strength, neutral gas pressure, and discharge tube radius. Experimental measurements, made in a radio-frequency excited magnetoplasma, are found to be in excellent agreement with the predicted values of critical magnetic field and phase velocity over a wide range of neutral gas pressures and several different discharge tube radii. On the basis of the agreement between theory and experiment, it is concluded that such a drift-type instability is responsible for the onset of fluctuations and anomalous diffusion in rf generated magnetoplasmas. (auth) (UK)

Thermonuclear Processes

3027 (CEA-N-1464) KAMOKOT PROBLEM. Alfonsi, Jean-Pierre; Boujot, Jean-Paul (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1971. 36p. (In French). Dep. NTIS (U. S. Sales Only).

A description is given of the way in which a numerical program is used to simulate the Tokamak experiment. The choice of mathematical model is discussed; the toroidal effect is neglected; the hydrodynamic description of a given plasma by the MHD system deduced from the BBGKY system is used. A two-fluid model with cylindrical geometry is then introduced, and a numerical treatment of the system obtained is indicated. (France)

3028 (CEA-R-4219) MAGNETOHYDRODYNAMICS OF THE FOCUS DISCHARGE (NONCYLINDRICAL SELF-CONSTRICTION). Vezin, Robert (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Aug 1971. 90p. (In French). Dep. NTIS (U. S. Sales Only).

The POTTER magnetohydrodynamic code was used. This code involves a two-dimensional fluid model with two temperatures T_e, and T_i and the transverse transport coefficients of a fully ionized plasma. When applied to the Focus geometry used at Limeil, temperatures consistent with the Bennett law, but much lower than those evaluated experimentally using x-ray absorbing foil techniques, are obtained. (France)

3029 (IAE-2025) STABILITY OF SINGLE-TURN COILS IN PULSED MAGNETIC FIELDS UP TO 1 MGs. Andrianov, A. M.; Demichev, V. F.; Eliseev, G. A.; Levit, P. A. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 10p. Dep. NTIS (U. S. Sales Only).

Experiments on the stability of single-turn coils under the action of pulsed magnetic fields as high as 1 MG are described. Copper, beryllium and chromium bronzes, various steels, niobium, molybdenum, tantalum, tungsten and some other metals were used as coil materials. A 58-kJ capacitor bank of low inductance was used as a current source. Preliminary estimates of the stability of coil materials were based on their dynamic and thermal characteristics. In particular, the impact strength and the critical speed of impact of the materials were taken into account. The stability criteria obtained are in qualitative agreement with the experimental results of the study of the behavior of the materials in strong pulsed magnetic fields. Tantalum is the most stable of all the materials tested. Tantalum coils can be used for repeated production of pulsed magnetic fields as high as 1 MG. Tantalum also shows itself to be the best material for generating stronger fields in short coils. The maximum field of 3.1 MG produced in a tantalum coil was half as much again as that produced in a copper coil. Strong plastic flows and ejection of a melted and vaporized surface material are the principal kinds of coil destruction that limit the strength of the magnetic field. (auth)

3030 (SC-DR-710324) PEGASUS CAPACITOR BANK. Kutac, Ken J. (Sandia Labs., Albuquerque, N. Mex.). Nov 1971. 73p. Dep. NTIS.

The Pegasus capacitor bank is a 600-kJ, 60-kV discharge source that will be used in plasma physics research. The bank contains 156 capacitors (1.85 μF, 60 kV) in the primary and 12 capacitors (0.7 μF, 75 kV) in the preionization section. Spark-gap switching is used on all the capacitors and in the triggering system of the bank. Jitter times of 20 nsec are obtained on all the spark-gap switches. The five sections of the bank are described in detail. These sections are (1) charging, (2) trigger, (3) capacitor and spark gap, (4) load, and (5) electronic control. This system has been installed at Sandia Laboratories and is being made operational. (auth)

3031 MATERIALS FOR NUCLEAR FUSION REACTORS. PRIMARILY ON VACUUM VESSELS. Ogawa, Y. (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 17: No. 5, 26-30(May 1971). (In Japanese).

Effort is being concentrated on confinement of ultrahigh-temperature plasma in studies on nuclear fusion, and the plasma necessary for reactor cores is generally expected to be obtained within ten years. However, construction of reactors, cooling, generation of intense magnetic fields, etc., which require long-term development, are being neglected. Torus-type nuclear fusion reactors are composed of the reactor core, vacuum vessel, blanket, and magnetic coil. Requirements for vacuum-vessel materials are sufficient high-temperature strength, large thermal conductivity and small thermal expansion, low vapor pressure, small sputtering, good compatibility, and good weldability and workability. Molybdenum and niobium are compared with each other concerning these points. Irradiation damage of structural materials for the vacuum vessels and blankets, radiation dissolution of coolants, and property change of superconductive magnets are considered; the vacuum vessels are under the most severe conditions. Strengthening by alloying elements, recovery of irradiation hardening by annealing, helium embrittlement and swelling by voids, and sputtering are discussed in connection with high-temperature properties of materials. Behavior of hydrogen produced by nuclear conversion and hydrogen absorption especially by niobium containing zirconium constitute serious problems for the vacuum vessels. (Japan)

3032 ELECTRICAL-TECHNICAL PROBLEMS IN FUSION MACHINES. Knobloch, Albert; Schmitter, Karlheinz; Wipf, Stephan Lorenz (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Elektrotech. Z., A; 92: No. 5, 265-72(1971). (In German).

Electrotechnical problems in fusion machines are reviewed. Stationary toroidal plasma machines (stellarator, torsatron), slowly pulsed or quasistationary toroidal plasma machines (tokamak), and briefly pulsed plasma machines are discussed. Magnetic field production is discussed for conventional, cryogenic, and superconductive coils. Superconductive materials and their properties are described, and the behavior of superconductors in transient magnetic fields and problems encountered with large superconductive coils are investigated. Energy supply is treated with respect to mechanical storage, magnetic storage, and electrostatic storage. (H.B.G.)

3033 HIGH-CURRENT AND GOOD-EMITTANCE ION SOURCE. Nunogaki, Masanobu; Itoh, Juro; Akimune, Hideo; Suita, Tokuo (Osaka Univ.). Jap. J. Appl. Phys.; 10: No. 11, 1640(Nov 1971).

An ion source applying a beam-plasma interaction to the production of source plasma was investigated. The source is designed in order to obtain a high-current, small-emittance ion beam for fusion research. When an electron beam of 200 mA being accelerated to 1 keV is injected into the interaction chamber, the configuration of beam and plasma varies through two distinct modes. The source and an emittance diagram are described. (M.O.W.)

3034 HIGH-SPEED GAS VALVE. Vladimirov, N. F.; Komel'kov, V. S.; Modzolevskii, V. I. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 207-9(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 177-9(Jan-Feb 1971).

The layout of a gate for high-speed admission of gas into gas-filled vacuum chambers used in gas-discharge, plasma, and gas-dynamic experiments is described. The opening of the gate barrier, which consists of a thin metal or organic tape, is achieved within 0.5 to 2 μsec by means of a plasma jet with external currents (a fountaining pinch). The barrier ruptures within an indicated time as the result of combined action of the high pressure developed by the magnetic field of the currents and the temperatures on the front of the jet. A description is given of a gate with multiple action, as well as engineering characteristics based on experimental data. (auth)

3035 STELLARATOR CONFIGURATION UTILIZING INTERNAL SEPARATRICES. Furth, Harold P.; Johnson, John L.; Sheffield, George V. (to United States Atomic Energy Commission). U. S. Patent 3,607,627. 21 Sep 1971. Filed 10 Oct 1968.

A stellarator having internal separatrices such that the equilibrium properties are favorable for stability is described. A method for providing a stable-equilibrium region for confining a plasma both inside and outside the internal separatrices, and for maximizing the three functions of large rotational transform, strong shear θ, and deep well V″ is described. (auth)

3036 THERMONUCLEAR REACTOR TOMORROW. Coutant, Jacques (CEN, Fontenay-aux-Roses, France). Sci. Progr. Decouverte; No. 3436, 4-15(Aug 1971). (In French).

The likely demands for energy in the next decade emphasize the importance of having an economical and inexhaustible energy source. The exploitation of thermonuclear energy is a very fashionable subject. The peaceful uses of nuclear fusion involve many problems. If controlled nuclear fusion is to be achieved, three conditions must be satisfied: the particle density must be sufficiently high, the confinement time sufficiently great, and the temperature sufficiently high. Different types of machines with open and closed configurations are examined. The American machines such as the Stellarator and the Russian Tokamak machines are compared. The importance of the Russian-type machines is underlined. It is not unlikely that the study of such controlled fusion machines will result in the practical exploitation of controlled fusion energy. (France)

3037 REVIEW OF THE MAJOR CONTAINMENT SYSTEMS IN THE U. S. CONTROLLED THERMONUCLEAR RESEARCH PROGRAM. Kemp, E. L. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 442-4(oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3038 MATERIALS PROBLEMS OF FUSION REACTORS. Frost, B. R. T. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 445-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3039 TRITIUM AND FUSION POWER. Hennelly, E. J. (E. I. duPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 446(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3040 COMMENTS ON THE POWER BALANCE PARAMETERS Q AND ϵ AS MEASURES OF PERFORMANCE FOR FUSION POWER REACTORS. Persiani, P. J.; Lipinski, W. C.; Hatch, A. J. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 448-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3041 ASYMPTOTIC MAGNETIC SURFACES. Spies, Guenther Otto; Lortz, Dietrich (Institut fuer Plasmaphysik, Garching, Ger.). Plasma Phys.; 13: No. 9, 799-816(Sep 1971).

Toroidal magnetic fields $B = \sum_{\nu\geq 0} \epsilon^\nu B_\nu$, where the unperturbed field B_0 has closed lines of force, are considered. It is shown that single-valued formal solutions $F = \sum_{\nu\geq 0} \epsilon^\nu F_\nu$ of the equation $B \cdot \nabla F = 0$ exist, and that the asymptotic magnetic surfaces F = const. are uniquely determined up to any order. Recurrence formulae are derived that allow calculation of any order of F from its lower orders, and explicit expressions are given for F_0 that depend on whether the rotational transform is of the same or of higher order than the perturbing field. For the special cases of stellarator-like vacuum fields, a necessary condition is derived for the asymptotic magnetic surfaces to be toroidally closed. As another application, the lowest order of an adiabatic invariant is constructed for the longitudinal guiding-center motion. (auth)(UK)

Wave Phenomena

3042 (CEA-CONF-1860) SPATIAL AND TEMPORAL H.F. PLASMA RESPONSE TO AN EXTERNALLY APPLIED PULSE. Demuliere, P.; Guillemot, M.; Olivain, J.; Perceval, F.; Quemeneur, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 10p. (CONF-710929-3). Dep. NTIS (U. S. Sales Only).

From third international conference on quiescent plasma; Elsinore, Denmark (20 Sep 1971).

The response of the electrons, in a collisionless plasma, to a fast small-amplitude electrical pulse was investigated theoretically and experimentally. The response, which is proportional to the excitation, is pseudo-periodic after a delay equal to z/V_{gmax}, V_{gmax} being the maximum group velocity of the induced waves and z the distance between the emitter and the receiver. The amplitude of the signal decreases and its pseudo-period increases with increasing z. (France)

3043 (CEA-CONF-1861) NUMERICAL INVESTIGATION OF THE EFFECT OF HEAT TRANSPORT ON COLLISIONAL DRIFT WAVES. Brossier, P.; Deschamps, P.; Gravier, R.; Pellat, R.; Renaud, C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1970]. 8p. (CONF-710929-1). Dep. NTIS (U. S. Sales Only).

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

A detailed numerical investigation of the linear dispersion relation for pressure-gradient-driven drift instabilities in a collisional plasma is described. Besides effects related to the finite thermal conductivity coefficients for both ions and electrons, correction terms are included in the equation for a low magnetic field region, and for heat exchange between the ion and electrons fluids, which may become important for ions and electrons at different temperatures. The effect of the magnetic field, B, on the growth rate and frequency is an evolution of the fluctuation spectrum into a turbulent one, and a deviation from the 1/B dependence. Corrections due to finite ν_i/Ω_{ci} are stabilizing, and heat exchange is important only at large densities (for instance $>10^{11}$ cm^{-3}). Comparison with available experimental data shows that high azimuthal and parallel wave numbers are more stable than those predicted from the linear theory. (France)

3044 (CEA-CONF-1863) RESONANT CHARACTERISTICS OF COLLISIONLESS DRIFT WAVES IN HYDROGEN PLASMA: COMPARISON BETWEEN EXPERIMENTAL RESULTS AND LINEAR THEORY. Boissier, R.; Brossier, P.; Deschamps, P.; Gravier, R.; Pellat, R.; Renaud, C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1971]. 8p. (CONF-710929-4). Dep. NTIS (U. S. Sales Only).

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

Spontaneous collisionless drift waves driven by a pressure gradient perpendicular to the confining magnetic field are observed in the low-β plasma of the ODE device. The experiment was designed specifically to study this instability, characterized by very long parallel wavelengths, which results from the resonant coupling between the wave and the electrons. A double-ended device produces a 5.4-m-long collisionless hydrogen plasma confined by a uniform magnetic field $B_0 \leq 5$ kG. Detailed measurements of the unstable modes were performed by correlation techniques using a 10-MHz-bandwidth real time correlator. The experimental dispersion curves are compared with the computed solutions of the linear dispersion relation. The agreement between theoretical and experimental parallel wavelengths is better than a factor of 2 when B_0 increases from 1.5 to 3 kG. To change the reflecting conditions for resonant electrons, two mirror coils were located at each end of the column. The subsequent variation of ω and $\lambda_\parallel$ for drift modes demonstrates the importance of end effects on the selection of the unstable parallel wavelengths. (auth)

3045 (CEA-CONF-1864) LARGE-AMPLITUDE WAVE INTERACTION WITH A PLASMA: TRAPPING EFFECTS. Guillemot, M.; Olivain, J.; Perceval, F.; Quemeneur, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1971]. 14p. (CONF-710929-5). Dep. NTIS (U. S. Sales Only).

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

In order to obtain the theoretical distribution function, the Vlasov equation is solved using the free-trajectories method. These calculations, valid for weakly damped waves, show that the particles are divided into two classes: the first consisting of untrapped particles and the other consisting of particles trapped in the potential well of the wave. For an initially Maxwellian distribution the instantaneous distribution function is numerically calculated. (M.O.W.)

3046 (CEA-CONF-1865) AMPLITUDE OF ELECTRON PLASMA WAVE ECHOES. Guillemot, M.; Olivain, J.; Perceval, F.; Quemeneur, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires); Matthieussent, G. (Paris Univ., Orsay (France). Laboratoire de Physique des Plasmas). [1970]. 10p. (CONF-710929-6). Dep. NTIS (U. S. Sales Only).

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

New experimental results of spatial plasma wave echoes are presented. They show especially: the observed echoes are dominated by collective effects; the dissymmetric role played by the

two emitters on the amplitude and on the profile of the echo; and the decay of the amplitude of the echo under the influence of a homogeneous noise (plasma noise) and an inhomogeneous noise (random noise generator). (auth)

3047 (EUR-CEA-FC-606) ACCESSIBILITY OF EXACT NONLINEAR STATIONARY STATES IN WATER-BAG MODEL COMPUTER EXPERIMENTS. Finzi, U. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1971. 23p. Dep. NTIS (U. S. Sales Only).

The Bernstein, Greene, and Kruskal stationary states of a four-contour water-bag system are discussed in detail. The time evolution of a linearly stable two-stream system towards an exact nonlinear stationary state is shown to take place in computer experiments when suitable initial conditions are adopted. A method for the excitation of pure modes in a uniform water-bag system is presented. (France)

3048 (FRNC-TH-85) DIFFRACTION OF A ELECTROMAGNETIC PLANE WAVE BY A CYLINDRICAL PLASMA. Arfeux, Bruno (Paris Univ., Orsay (France). Faculte des Sciences). [1969]. 64p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The experimental study presented is a verification of the laws of diffraction of a plane electromagnetic wave by a rotationally symmetric cylindrical plasma column produced by a hollow-cathode source. The study contains: (1) a general bibliographic study on methods of calculation of diffraction, (2) a description of experimental apparatus for production and measurement of the plasma, and (3) an analysis of results obtained. The electron density profiles obtained by means of a Langmuir probe showed that approximation with geometric optics is applicable. Calculation of the diffraction of a short-wavelength electromagnetic wave allows establishment of a preliminary diffraction diagram that may be verified by experiment. (tr-auth)

3049 (FRNC-TH-105) FAST WAVES IN PLASMA GUIDES Jouineau, Jean-Pierre (Paris Univ., Orsay (France). Faculte des Sciences). 1969. 59p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Wave propagation in a plasma column is studied, assuming that the electron temperature is equal to zero. The coupling between guide modes and plasma modes when their propagation frequencies are of the same order of magnitude is investigated. The dispersion curves of the fast wave in the principal plasma mode were obtained. It was shown that the secondary plasma modes can propagate along the plasma column with phase velocities higher than the velocity of light. A fast wave component is necessary to explain the couplings observed. These couplings have an important effect on density measurements. When the coupling occurs, concentration of hf power (2 or 3 watts) in the plasma can be used to create a hf plasma. (France)

3050 (IPP-6/98) WAVE PROPAGATION IN PLASMAS WITH FLUCTUATIONS. Salat, A. (Institut fuer Plasmaphysik, G,m,b,H,, Garching (West Germany)). Jul 1971. 74p. Dep. NTIS (U. S. Sales Only).

A theory that generalizes and corrects previous theories on wave propagation in fully ionized unmagnetized plasmas with fluctuations is presented. On the basis of Klimontovitch's method, a unified treatment is given for both "microscopic" density fluctuations due to the discrete particle structure and for "macroscopic" fluctuations. Longitudinal and transverse scattered waves, i.e., Coulomb collisions and "scattering," are included. A general plasma conductivity $\sigma(\omega,k)$ as a function of the frequency ω and the wave number k of the wave is derived for the case when the phase velocity $\omega/|k|$ is much larger than the thermal velocities. σ is expressed as a function of the density correlation functions $S_{\alpha\beta}(\omega',k')$; α, β = electron- ion. The effects of $k \neq 0$ on σ are discussed both generally and in a specific example where the relative significance of microscopic and macroscopic fluctuations can be seen. (auth)

3051 (KHFTI-71-13) RESONANCE PHENOMENA IN CONFIGURATIONS WITH HELICAL MAGNETIC AXES WHEN CALCULATING TOROIDALITY. II. Aleksin, V. F.; Nemov, V. V.; Shishkin, A. A. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

This report is a continuation of Part I (1970) by the same authors and examines resonance phenomena in configurations with a helical magnetic axis while turning in a torus. The domain of exact resonance and also the approaches to this domain from the area of nonresonance are explored. The possibility of complicating the magnetic structure during detuning of some characteristic frequency from its resonance value is discussed. (tr-auth)

3052 (KHFTI-71-25) INVESTIGATION OF AMPLITUDE REFLECTION OF ELECTROMAGNETIC WAVES FROM BOUNDARIES OF ANISOTROPIC PLASMA. Adamov, I. Yu.; Berezhnyi, V. L.; Dushin, L. A.; Lebedev, P. M.; Kononenko, V. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1971. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

The characteristic amplitude of a reflected electromagnetic wave from an anisotropic plasma was calculated by means of an electronic computer. The boundary of the plasma was oriented perpendicularly to the magnetic field. The dependence of the amplitude upon plasma density, number of encounters, magnetic field, and the frequency of the signal probing the plasma, were determined. These relations may be used in a practical fashion for defining the density of an anisotropic plasma and measuring the amplitude of a reflected electromagnetic wave. (tr-auth)

3053 (NP-19061) ANOMALOUS ABSORPTION OF ELECTROMAGNETIC WAVES IN MAGNETIZED PLASMA. Preprint No. 94. Batanov, G. M.; Gorbunov, L. M.; Sarksyan, K. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1971. 9p. (In Russian). Dep. NTIS (U. S. Sales Only).

Absorption of electromagnetic waves (of the SHF range) in magnetized collisionless plasma is experimentally analyzed for $\omega_{eH}/\omega_0 \geq 0$ and $\omega_{Le}/\omega_0 < 1$. The dependence of transmission factors and wave absorption on incident wave power is determined. It is found that wave absorption is maximum at some wave power. The experimental results are compared with theoretical results. The dependence of the effective collision frequency on wave power is presented. It is assumed that the observed phenomenon of anomalous absorption is related to the development of parametric instability in the plasma. (JPRS)

3054 (NP-19083) MICROWAVE ABSORPTION BY PLASMA ESSENTIALLY INHOMOGENEOUS ALONG THE MAGNETIC FIELD LINES. Arkhipenko, V. I.; Budnikov, V. N. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). 1971. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

The microwave power absorption by plasma, essentially inhomogeneous along the magnetic field lines was investigated. Plasma was produced by 3-cm microwaves under electron cyclotron resonance conditions at the end of a long narrow discharge tube filled with argon. The tube diameter was 2.5 cm, the length 70 cm, and argon pressure 10^{-2} mm Hg. The density distribution decreased exponentially along the tube. To the middle of the tube, microwave power f = 2370 MHz was delivered by a 10-cm waveguide, directed normally to the tube axis. The power range was 0.01 to 10 watts, and the electrical field direction was perpendicular to the stationary magnetic field direction. Plasma parameters were $n = 10^{10}$ to 10^{12} cm^{-3} and $T_e = 2$ to 2.5 eV; such conditions were approximately fulfilled for operating frequencies $\omega_{He} = 3\omega$, $\omega_p \geq \omega$. Effective microwave absorption (up to 60%) was found to take place in the plasma. It was essential that inside the 10-cm waveguide the mean plasma density exceed the critical value ($n_c = 7 \times 10^{10}$). The plasma density increased and, hence, the microwave power absorption was found outside the 10-cm waveguide at distances 10 to 25 cm. The microwave power absorption region was localized near the cross section where the maximum density is equal to the critical one, n_c. The displacement of the cross section led to the displacement of the absorption region. It was found that under the experimental conditions a plasma waveguide was formed, along which the microwave power propagated to the cross section where $n_0 \approx n_c$ without visible attenuation. The discussion concerning the location of the absorption region is based on the theory of wave transformation in plasma with two-dimensional inhomogeneities. (auth)

3055 UPPER-HYBRID RESONANCE ABSORPTION, EMISSION, AND HEATING OF AN AFTERGLOW PLASMA COLUMN. Stenzel, R. L.; Gould, R. W. (California Inst. of Tech., Pasadena). J. Appl. Phys.; 42: No. 11, 4225-35(Oct 1971).

Microwave absorption and emission and electron temperatures of a nonuniform axially magnetized afterglow plasma column in a waveguide geometry were investigated experimentally. Frequency ω and magnetic field ω_c were chosen to satisfy the upper-hybrid resonance condition $\omega^2 = \omega_c^2 + \omega_p^2(r)$, where $\omega_p(r)$ is the local electron plasma frequency. Nearly perfect absorption is observed in the range of upper-hybrid frequencies, while at other frequencies the absorption coefficient is essentially zero. The sharp absorption onset at the maximum upper-hybrid frequency yields an accurate measure for the peak electron density. Density decay and profile in the plasma column are observed—the latter using a new technique. In the range of high absorption the noise emission approaches the blackbody limit. The electron temperature is measured with a radiometer and a reference noise source in a new technique yielding both spatial and time dependence with-

out perturbing the plasma. The time resolution is obtained by a sampling technique. The spatial resolution results from the fact that upper-hybrid resonance absorption and emission are confined to a narrow resonant layer. This property is also used to heat the electrons locally and observe the thermalization process. (auth)

3056 NEW EXPERIMENTS WITH THREE-PULSE ECHOES. Smith, R. R.; Harp, R. S. (California Inst. of Tech., Pasadena). J. Appl. Phys.; 42: No. 11, 4246-51(Oct 1971).

Experiments are reported on three-pulse echoes in rare-gas magnetoplasmas. The results are consistent with a periodic perturbation in frequency space of the electron density. If this perturbation is due to a diffusion in physical space of "hot" electron bands, then it is not a simple diffusion governed by electron–neutral collisions. Absorption and emission are observed that are periodically modulated after the application of two short S-band pulses. The clear relation between the measurements of echo amplitudes and of emission and absorption spectra shows that these experiments will be useful tests of future three-pulse echo theories. (auth)

3057 EXPERIMENTAL STUDY OF THE BALLISTIC SECOND-ORDER SPATIAL PLASMA WAVE ECHO. Ripin, Barrett Howard. College Park, Md.; Univ. of Maryland (1971). 182p. University Microfilms Order No. 71-24,288.

Thesis.

Plasma-electron-echo experiments are described in which the relation between the echo wavelength and frequency is given by $\omega_3/k_3 = v_c$, where v_c is approximately equal to the velocity at which the electron distribution function has maximum slope. It is concluded that the echo response is dominated by free-streaming electrons. Other evidence is also presented which supports this conclusion. The experimental results corroborate many of the properties of free-streaming disturbances derived for first- and second-order perturbations from an expansion of the Vlasov–Poisson system. Numerical integrations of the derived expression for the second-order ballistic echo electric field are presented for the cases of a Maxwellian distribution function and the experimentally measured electron distribution function. The latter results compare favorably with experiment. The mechanism by which the electrons are perturbed by the externally applied fields is found to influence the detailed structure of the echo response. (Diss. Abstr. Int., B)

3058 DECAY OF ELECTRON PLASMA WAVES INTO OTHER ELECTRON PLASMA WAVE MODES. Franklin, R. N. (Oxford Univ.); Smith, G. J.; Hamberger, S. M.; Lampis, G. Phys. Lett.; 36A: No. 6, 473-4(11 Oct 1971).

The decay of electron plasma waves propagating in a cylindrical plasma column into well-defined modes is observed over a range of frequencies and shown to be a three-wave resonant process. A frequency threshold is predicted and confirmed. (auth)

3059 EXCITATION OF ELECTROSTATIC WAVES IN NONUNIFORM MAGNETOPLASMAS. Brownell, John Howard. Stanford, Calif.; Stanford Univ. (1971). 210p. University Microfilms Order No. 71-23,491.

Thesis.

In order to understand the experimentally observed stabilization of a plasma column by high-frequency fields, the process of rf plasma excitation and energy absorption is analyzed rigorously. The electric field excited in a nonuniform magnetoplasma slab (with $\vec{B}$ perpendicular to the density gradient) by an external source is calculated, and the impedance presented by a grid–plasma system is found. Electrostatic waves that propagate across the magnetic field parallel to the density gradient are considered and particular attention is paid to frequencies close to the upper hybrid frequency. An integral equation in wave number space, exact within the assumption of neutrality and of low plasma pressure, is derived for the electric field, and it is shown that a variational principle exists for the admittance of the grid–plasma system. In addition, a differential equation for $\vec{E}(k)$ is found. These two methods take the entire real k-axis into account, and therefore it is possible to formulate a validity criterion for the long-wavelength method used in most previous work. The cold plasma impedance shows that if the grids are externally excited the voltage across the plasma decays in time due to the continuous spectrum of upper-hybrid oscillators. Upon introducing a finite electron temperature it is found that the spectrum becomes discrete, making the impedance purely relative. However, the resonances are closely spaced, giving rise to the possibility of plasma heating if a randomization mechanism is present. Furthermore, evidence is given that the small time behavior of a cold and of a hot plasma are the same, implying that with the randomizing mechanism the power absorption would be the same. (Diss. Abstr. Int., B)

3060 AVERAGED LAGRANGIAN METHODS AND NEARLY PERIODIC MOTIONS IN PLASMAS. Dewar, Robert Leith. Princeton, N. J.; Princeton Univ. (1971). 147p. University Microfilms Order No. 71-23,354.

Thesis.

The averaged Lagrangian formalism of Whitham for treating nearly periodic motions is adapted to some problems in plasma physics. When applied to single-particle motion in a strong magnetic field, the formalism is shown to lead in a simple manner to the equation of motion for the guiding center and to the constancy of the adiabatic invariant. Similarly, single-particle motion in the potential of a slowly changing wave may be treated, in which case the method easily generalizes the usual action-angle representation. For an untrapped particle, this representation is shown to correspond to the classical limit of the Bloch representation. The method is also applied to the problem of small-amplitude wave propagation in slowly changing (in space and time) background plasmas. Both ideal hydromagnetic and collisionless plasmas may be treated, with the restriction that there are no resonant particles. The conservation theorems for wave action, total momentum, and total energy are derived, and the splitup into subsystems is discussed. As an application of this adiabatic wave theory, the modulational stability of an electron plasma wave is investigated. Nonlinear fluid effects are shown to be stabilizing, but particle effects of the nonlinear Landau damping type are shown to lead to initial growth of modulations. (Diss. Abstr. Int., B)

3061 NONLINEAR SCATTERING OF CYCLOTRON HARMONIC PLASMA WAVES. Chang, Robert P. H. Princeton, N. J.; Princeton Univ. (1971). 127p. University Microfilms Order No. 71-71-23,349.

Thesis.

The problem of nonlinear interactions of high-frequency longitudinal plasma waves in a magnetic field is studied in some detail. In particular, the nonlinear wave–wave scattering of cyclotron harmonic waves is studied both experimentally and theoretically. In the first set of experiments it is shown that a finite-amplitude traveling cyclotron harmonic wave may decay into two similar waves by the process of resonant mode–mode coupling. In the second set of experiments, the nonlinear Landau damping and growth of longitudinal waves in a magnetic field is studied. It is observed that a finite-amplitude cyclotron harmonic wave may decay nonresonantly into a similar, small-amplitude wave. The results demonstrate that under appropriate conditions a perturbative solution of the Vlasov–Maxwell equations can be used to explain nonlinear phenomena in a warm plasma. (TSS) (Diss. Abstr. Int., B)

3062 SCATTERING COEFFICIENTS OF ONE-DIMENSIONAL PLASMAS OF EPSTEIN-TYPE PROFILES WITH RANDOM IRREGULARITIES. Wasneski, Richard J. Philadelphia; Drexel Univ. (1971). 130p. University Microfilms Order No. 71-24,846.

Thesis.

The problem of electromagnetic scattering by inhomogeneous one-dimensional plasmas with electron density of Epstein-type profiles, superimposed with random irregularities, is studied by means of a perturbation method. An exact Green's function is derived for the problem, and the resulting integral equation is solved approximately by the Neumann iterative technique. Coherent and incoherent power reflection and transmission coefficients are obtained to a consistent second-order accuracy, and an expression is given to define the parameter validity region of the solution. In addition, the incoherent reflection coefficient is graphically displayed for an interesting parameter range. Where meaningful, the special case of the half space of plasma is compared to an exact Monte Carlo computer experiment for a plasma slab. It is shown that, for the given region of validity, the solution compares favorably with experiment. (Diss. Abstr. Int., B)

3063 EFFECT OF TEMPERATURE ON RATE OF GROWTH OF LEADING EDGE OF A COLLISIONLESS SHOCK. Cairns, R. A. (Univ. of St. Andrews, Fife, Scotland). Plasma Phys.; 13: No. 9, 725-30(Sep 1971).

An equation is derived for the characteristic length scale of the leading edge of a laminar shock propagating perpendicular to a magnetic field into a hot plasma. Where the upstream plasma has a low value of β, it is shown that the main correction to the cold plasma result comes from the thermal motion of the ions, rather than the electrons. This may be of interest in connection with current theories on collisionless shocks that start from a laminar leading edge, then consider the instabilities that can occur and that will give rise to a high level of turbulence in the middle of the shock. (auth)(UK)

3064 STUDY OF COUPLED ELECTRO-ACOUSTIC AND ELECTROMAGNETIC WAVES IN AN INHOMOGENEOUS COM-

PRESSIBLE AND LOSSY PLASMA. Verma, Yash Pal. Boston; Northeastern Univ. (1969). 199p. University Microfilms Order No. 71-25,767.

Thesis.

Wave propagation in a one-fluid compressible, inhomogeneous, and lossy plasma is studied. Coupling between the electroacoustic and electromagnetic waves is investigated analytically. The inhomogeneity of the medium is due to the variation of the electron density, collision frequency and the temperature along the vertical direction only (z-direction). The numerical results show that with the increase of frequency (within the limit of the parameters chosen here) the energy transfer from the incident electromagnetic wave to the electroacoustic wave decreases when all other parameters remain fixed. It is also observed that as the electron temperature increases (thereby increasing the electron adiabatic sound velocity) the transfer of energy from the incident electromagnetic wave to the electroacoustic wave increases when all other parameters remain fixed. Since the coupling between the em wave and p wave is mainly due to the inhomogeneity of the medium, the transfer of energy from the incident electromagnetic wave to the pressure wave varies with the height z. (Diss. Abstr. Int., B)

3065 APPLICATION OF THE METHOD OF CHARACTERISTICS TO TRANSIENT PROPAGATION IN A STRATIFIED PLASMA. Field, John Clark. Boston; Northeastern Univ. (1969). 131p. University Microfilms Order No. 71-25,758.

Thesis.

The partial differential equations describing plane wave propagation in the direction of inhomogeneity in a stratified plasma are developed. These equations are then put into a canonical form. This is a form in which the canonical variables are differentiated along their characteristics. A numerical procedure based on the trapezoidal method is then developed to integrate the canonical variables along their characteristics. This procedure is then applied to treat several transient plasma-propagation problems. One particularly interesting case is that of a very narrow pulse incident on a plasma slab. By taking the Fourier transforms of the reflected and transmitted waves, the reflection and transmission coefficients, respectively, are found. (Diss. Abstr. Int., B)

3066 ELECTROMAGNETIC WAVE PROPAGATION AND SOURCE RADIATION IN SPACE–TIME PERIODIC MEDIA. Elachi, Charles. Pasadena, Calif.; California Inst. of Tech. (1971). 141p. University Microfilms Order No. 71-27,098.

Thesis.

The electromagnetic wave equations for the fields, potentials and Hertz vectors are derived and a Lorentz gauge is given for space–time dependent media. Electromagnetic wave propagation, electric and magnetic dipole radiation, and Cherenkov and transition radiation in sinusoidally space–time periodic dielectric plasma and uniaxial plasma are studied and numerous radiation patterns are given. A special radiation effect in the uniaxial plasma is investigated. Finally the study is extended to general space–time periodic media (i.e., $\epsilon = \epsilon_0\epsilon_r[1 + \epsilon_1 f(Kz - \Omega t)]$ where $f(\xi)$ is a periodic function). (Diss. Abstr. Int., B)

Radiation Physics and Shielding

Refer also to abstracts 3817, 3818, and 3820.

Radiation Physics

Refer also to abstracts 2319 and 3095.

3067 (BNWL-SA-3998) ENERGY EJECTED IN FAST PROTON COLLISIONS. Glass, W. A.; Toburen, L. H.; Wilson, W. E.; Roesch, W. C. (Battelle Pacific Northwest Labs., Richland, Wash.). Sep 1971. Contract AT(45-1)-1830. 24p. (CONF-711028-1). Dep. NTIS.

From third symposium on microdosimetry; Stresa, Italy (17 Oct 1971).

An analysis of the relative importance of various processes by which the energy of fast protons is transferred to a medium of low atomic number shows that, in the proton energy range 300 to 1700 keV, about 50 to 60% appears as kinetic energy of the secondary electrons and 25 to 30% is involved in overcoming the binding energy of these electrons. The remaining 10 to 20% can be accounted for as primary excitation, recoil, etc. Distributions in angle and in the kinetic energy associated with electrons ejected by protons in passing through various gas absorbers will be presented. These distributions are derived from experimentally measured cross sections. Effects of chemical binding energy on electron ejection cross sections will be considered. Distributions of secondary electrons in energy will be compared with results obtained using a binary encounter theory to illustrate the degree of applicability of this semi-classical treatment. The importance of secondary electrons for energy deposition in small sites will be considered. (auth)

3068 (FEI-218) PERTURBATION THEORY APPLICATION TO THE PROBLEMS OF SCATTERED RADIATION. Petrov, Eh. E.; Shemetenko, B. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1970. 26p. (In Russian). INIS.

Formulas were obtained by the aid of the theory of small perturbations with which the effect of radiation scattering by thin sections could be calculated. As a practical application of these formulas a comparison of calculated and experimental data was made. (tr-auth) (INIS)

3069 TRANSMISSION OF ^{235}U FISSION FRAGMENTS IN SOLID MEDIA. Aiello, V.; Maracci, G.; Rustichelli, F. (EURATOM, Ispra, Italy). Phys. Rev., B; 4: No. 11, 3812-19(1 Dec 1971).

Transmission mesurements of the fission fragments arising in ^{235}U thermal-neutron-induced fission were performed in Mg, Al, Fe, and Ag by using a back-to-back fission chamber. From the transmission curves, it is possible to derive the relative atomic stopping powers of the different targets and the ranges of the fission fragments in the elements investigated. The experimental results are compared with the theoretical calculations of Lindhard, Scharff, and Schiøtt concerning the loss of energy of heavy ions in matter. (auth)

3070 WHAT IS A CURIE OF GAMMA RADIATION. Tsenter, E. M. At. Energ. (USSR); 31: No. 1, 74-5(Jul 1971). (In Russian).

The history of the definition of a curie of radioactivity is traced from its earliest use until the present, with a discussion of the nuances of meaning attached to it. The first widely accepted definition, from the Brussels International Congress was: the quantity of radon in equilibrium with 1 g of Ra. A more modern usage involves the "gamma-equivalent" which is an amount of radioactive preparation, the γ-radiation from which at a distance of one meter furnishes one unit of intensity of exposure, which, in one system of units is an ampere per kilogram. The various aspects of this concept are explored. (K.S.W.)

3071 VARIATION OF IONIC CHARGE OF FISSION FRAGMENTS DURING THEIR PASSAGE THROUGH THIN METALLIC ABSORBERS. Albrecht, H.; Muenzel, H. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys.; 247: No. 2, 166-79(1971). (In German).

An experimental setup was used to measure the energy and mass as well as the ionic charge of fission products emitted by a ^{252}Cf-spontaneous fission source is described. The fragments were deflected in a magnetic field of 9700 Oe and were detected by means of two position-sensitive semiconductor detectors. Thin foils of Al, Ni, Ag, and Au were used to investigate the influence of metallic-absorber materials on the ionic charge Q. Within the limits of experimental error it was found that Q only depends on the velocity v and the atomic number Z_I of the ions. The relative ionic charge $\gamma = Q/Z_I$ was found to vary solely with v. The results were compared with those of Moak et al., Almquist et al., Leischner, Opower et al., and with the theoretical predictions of Bohr. An empirical formula proposed by Leischner was used to fit the experimental data. (auth)

3072 EFFECTIVE ATOMIC NUMBERS FOR SCATTERING PROCESSES OF GAMMA RAYS IN ALLOYS. Murty, M. Sriramchandra; Seetaramanath, M. N.; Rama Rao, J.; Parthasaradhi, K. (Andhra Univ., Waltair, India). Indian J. Phys.; 44: No. 1, 68-70(Jan 1970).

In earlier investigations of the effective atomic number for gamma interactions, essentially no discrimination was made between coherent and incoherent scattering processes. It was felt, therefore, that a detailed study of the effective atomic numbers for coherent and incoherent scattering processes in the energy region 0.1 to 1.33 MeV might be interesting. For this purpose two alloys of tin and a heavier element (lead) and two of tin and a lighter element (copper) in different proportions were chosen, and results are reported here. The effective atomic number for each scattering process retains its identity over the energy limits considered within the limits of errors. There is a significant difference between the two effective atomic numbers in the two alloys composed of Pb and Sn, while the difference is not discernible in the other two alloys composed of Sn and Cu. It thus appears that, in alloys consisting of heavy elements, the effective atomic numbers for coherent and incoherent scattering processes have to be treated separately. (L.M.T.)

3073 MEAN SCATTERING CROSS SECTION OF RADIATION DURING DIFFUSION. Mohanty, R. C. (Syracuse Univ., N. Y.). Indian J. Phys.; 43: No. 12, 730-4(Dec 1969).

A general discussion for mean scattering cross sections for radiation during diffusion is presented. Necessary general formulas are derived for mean number of scatterings, and application is made to one-dimensional media in which radiation of constant frequency undergoes diffusion. (auth)

3074 RADIATION FROM Ag BULK TARGETS AND THIN FILMS IRRADIATED BY ELECTRONS. Harutyunyan, F. R.; Hovhannissyan, R. A.; Rostomyan, B. O. (Inst. for Physical Research, Erevan). Phys. Lett.; 37A: No. 2, 163-4(8 Nov 1971).

The experimental investigation of radiation from Ag (thin films and bulk targets), irradiated by oblique 80-keV electrons, was made. The nature of this radiation is discussed. (auth)

3075 ATTENUATION OF X-RADIATION GENERATED AT CONSTANT POTENTIALS SUFFICIENT TO EXCITE K-RADIATION IN A TUNGSTEN TARGET. Soole, B. W. (Admiralty Research Lab., Teddington, Eng.). Phys. Med. Biol.; 16: No. 3, 427-37(Jul 1971).

Results of a recently described method of calculating the attenuation of the exposure-rate of x radiation generated at a constant potential are compared with published experimental data for radiation generated at tungsten targets by potentials above 69.5 kV, the tungsten K-absorption edge. It is shown that the K radiation does not provide a satisfactory explanation for the slightly, but consistently, greater penetration observed experimentally and that there is evidence that this is due to an initial loss of the less-energetic bremsstrahlung by absorption within the target. (auth) (UK)

3076 INCOHERENT PHOTON SCATTERING BY BOUND ELECTRONS. Pingot, O. (Faculte Polytechnique, Mons, Belg.). J. Phys. (Paris); 32: Nos. 5-6, 413-44(May 1971). (In French).

The differential cross section for the incoherent scattering of γ rays by the K-shell electrons of tantalum, samarium and silver was determined experimentally. This cross section is compared with the Klein–Nishina cross section for scattering angles between 20 and 160°. The results are in good agreement with the Shimizu function for small angles and large Z and with the Jauch–Rohrlich cross section for large angles and small Z. (France)

3077 PROJECTED-RANGE STRAGGLING OF 4- TO 24-MeV ELECTRONS IN ELEMENTAL MATERIALS. Tabata, Tatsuo (Radiation Center of Osaka Prefecture, Sakai, Japan); Ito, Rinsuke; Okabe, Shigeru; Fujita, Yoshiaki. Jap. J. Appl. Phys.; 10: No. 11, 1503-8(Nov 1971).

By modifying the derivative of the empirical expression of Ebert et al., for the transmission curve, an empirical equation is developed that expresses the projected-range straggling (PRS) distribution of electrons in the semi-infinite medium as a function of depth x, incident energy T_0, and atomic number Z of the absorber. Values of constrants in this equation are determined through least-squares fit to the experimental data of the present authors for 4.09 MeV $\leq T_0 \leq$ 23.5 MeV and $4 \leq Z \leq 79$. The ratio of the PRS parameter ΔR (full width at half-maximum of the PRS distribution) to the most-probable projected range is found approximately to be expressed by a power function of Z^2/T_0. An empirical relation which expresses ΔR as a linear function of the extrapolated, the projected, and the most-probable projected range is also given. (auth)

3078 MEASUREMENTS OF THERMAL RADIATION SCATTERING CHARACTERISTICS OF SUBMICRON REFRACTORY PARTICLES. Jacobs, W. R.; Williams, J. R. (Georgia Inst. of Tech., Atlanta). Trans. Amer. Nucl. Soc.; 14: No. 2, 428-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3079 ABSORPTION OF ELECTRON ENERGY IN MULTILAYER TARGETS. Berger, M. J. (National Bureau of Standards, Washington, D. C.); Seltzer, S. M.; Eisen, H. A.; Silverman, J. Trans. Amer. Nucl. Soc.; 14: No. 2, 887-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3080 GAMMA-RAY PENETRATION OF RIBBED SLABS. Green, D. W.; Morris, E. E.; Preiss, K.; Chilton, A. B. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc.; 14: No. 2, 888-9 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3081 GAMMA-RAY PENETRATION CORRECTION FACTORS FOR RIBBED SLABS. Chilton, A. B.; Morris, E. E. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc.; 14: No. 2, 889 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3082 APPLICATION AND ANALYSIS OF LARGE-SCALE INTEGRAL/DIFFERENTIAL SHIELDING EXPERIMENTS. Kaul, Dean C. (Defense Nuclear Agency, Washington, D. C.) Trans. Amer. Nucl. Soc.; 14: No. 2, 916(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3083 MEASUREMENTS OF FAST-NEUTRON AND SECONDARY GAMMA-RAY TRANSPORT THROUGH CONCRETE. Harris, L. Jr.; Kendrick, H. (Gulf Radiation Tech., San Diego, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 916-17(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3084 ANALYSIS OF NEUTRON AND GAMMA TRANSPORT IN CONCRETE USING MULTIGROUP CODES. Groce, David E.; Dupree, Stephen A.; Scott, William H. (Science Applications Inc., La Jolla, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 918-19 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3085 ANALYSIS OF NEUTRON AND GAMMA-RAY TRANSPORT USING THE O6R AND OGRE CODES. Straker, E. A.; Morrison, G. W. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 919-20(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3086 ANALYSIS OF NEUTRON AND GAMMA-RAY TRANSPORT USING THE SAM-CE CODE. Cohen, M. O. (Mathematical Application Group Inc., White Plains, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 920-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3087 USE OF THE MATRIX KERNEL FOR SECONDARY GAMMA-RAY SOURCES. Rohach, Alfred F. (Iowa State Univ., Ames). Trans. Amer. Nucl. Soc.; 14: No. 2, 922(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3088 MEASUREMENTS AND CALCULATIONS OF TIME-DEPENDENT GAMMA-RAY SPECTRA EMERGING FROM POLYETHYLENE SLABS PULSED WITH NEUTRONS. Burgart, C. E.; Straker, E. A.; Love, T. A.; Morgan, G. L.; Freestone, R. M. Jr. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 923-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3089 MONTE CARLO TRANSPORT ANALYSIS FOR FINITE GROUND-DISTRIBUTED GAMMA SOURCES. O'Dell, A. A.; Harris, N. A. (EG and G, Inc., Goleta, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 928-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3090 PSTE EXAMINATION OF A PULSE OF ELECTRONS WITH A CONTINUOUS ENERGY DISTRIBUTION AND AN ISOTROPIC ANGLE OF INCIDENCE. Cordaro, Matthew C. (Long Island Lighting Co., Hicksville, N. Y.); Zucker, Martin S. Trans. Amer. Nucl. Soc.; 14: No. 2, 930(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Shielding

Refer also to abstracts 3080–3082, 3467, 3494, and 3663.

3091 PASSAGE OF REACTOR NEUTRONS THROUGH SPACED SHIELDING. Bozin, G. M.; Degtyarev, S. F.; Kukhtevich, V. I.; (and others). pp 351-4 of Byulleten' Informatsionnogo Tsentra po Yadernym Dannym. /Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). (In Russian).

A characteristic feature of partial shielding from nuclear radiation is the attenuation of only that portion of the radiation which lies within a fixed solid angle. The probability of escape of scattered radiation beyond the limits of the shielded space may be estimated by dividing the shield into sections and spacing these sections at a given distance apart. A profile of these sections would then be made. Results are presented for experimental and calculated stud-

ies of fast-neutron flux ($E \geq 1.0$ MeV) passing through spaced shielding. Experimentally, three similar cylinders of lithium hydride, 70 cm in radius × 15 cm high, were used in various geometrical formations. The magnitude of the neutron flux for spaced shielding, resulting from the fact that the outward flow of a part of the scattered radiation into space does not compensate for the flux increase during proximity to the detector, is explained by the large distance between source and shield when the beam, incident upon the shield, is almost plane monodirectional. When the calculations are referred to this direction, assurance is had that for those cases in which the source is not positioned very far from the shield, shield spacing can produce a favorable effect. (K.S.W.)

3092 USE OF THE EXPONENTIAL TRANSFORMATION TECHNIQUE APPLIED TO THE S_n METHOD IN SHIELDING CALCULATIONS. Chilton, A. B. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc.; 14: No. 2, 653(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3093 GAMMA PHOTON BUILDUP FACTORS AND ALBEDOS FOR FINITE LAMINAR SHIELDS. Steyn, J. J. (NUS Corp., Rockville, Md.); Huang, R.; Harris, D. W. Trans. Amer. Nucl. Soc.; 14: No. 2, 890(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3094 CALCULATION OF THE LONG-LIVED ACTIVITY IN SOIL PRODUCED BY 500-GeV PROTONS. Gabriel, T. A.; Santoro, R. T. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 892-3(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3095 CROSS-SECTION COMPILATION AND EVALUATION FOR ANALYSIS OF CONCRETE SHIELDS. Young, P. G.; Jurney, E. T. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 917-18(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3096 TWO-DIMENSIONAL SHIELDING CALCULATIONS USING A COMBINATION OF DIFFUSION THEORY AND LINE-OF-SIGHT METHOD. Voosebrecker, H. (Interatom, Bensberg, Ger.). Trans. Amer. Nucl. Soc.; 14: No. 2, 937-8(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3097 INFLUENCE OF VARIATIONS IN COMPOSITION, PRIMARILY WATER CONTENT, ON NEUTRON PENETRATION THROUGH CONCRETE SLABS. Chilton, A. B. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc.; 14: No. 2, 938-9(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3098 CINNA: A NEUTRON SHIELDING CODE WITH HIGH-ENERGY RESOLUTION. Penkuhn, H. (CCR-EURATOM, Ispra, Italy). Trans. Amer. Nucl. Soc.; 14: No. 2, 939(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Solid-State Physics

3099 SOLID STATE DEVICES. Proceedings of the 1st Conference, Tokyo, September 26-27, 1969. J. Jap. Soc. Appl. Phys.; 39: Suppl., 1-263(1970). (CONF-690980).
Topics include the bulk effect and devices, device technology, field effect transistors, microwave devices, MOS and other devices, and photoelectric devices. 38 papers are presented. (W.H.K.)

Radiation Effects

Refer also to abstracts 2570, 2571, 2575, and 2963.

3100 (COO-1044-39) COLOR CENTERS AND RELATED PHENOMENA IN ALKALI HALIDE TYPE CRYSTALS. Final Technical Progress Report. Neubert, Theodore J. (Illinois Inst. of Tech., Chicago. Freund Instrumentation Lab.). Aug 1971. Contract AT(11-1)-1044. 42p. Dep. NTIS.
Electric-conductivity measurements were used to determine the energy of formation of lattice vacancies and the energy of motion of positive ion vacancies in KSCN, KCN, and NaCN. Techniques were developed for zone refining those salts, for growing single crystals, and for analysis of the crystals. Color centers in KCN were studied extensively and in NaCN, less extensively. A number of the centers, well known in KCl, were identified and characterized. Annealing experiments on crystals heavily x-irradiated at low temperatures were made to study the aggregation of F centers into M^+, M, R^+, R and N centers in NaF, NaCl, and KI. A beginning was made by a study of aggregate centers in NaBr. Thermal, optical, and x-ray-induced interconversions of aggregate centers also were investigated. Some of the higher-energy transitions of M^+, R, and R^+ centers in NaF, NaCl, and KI were identified by polarized absorption or, in some instances, by luminescence measurements. The dichroism of the M center was investigated in KCN, KBr, KI, NaF, and NaCl. An M center (F_2) resembles an H_2 molecule embedded in a dielectric medium. Accordingly the M_1 band corresponds to a $^1\Sigma_g^+ \rightarrow {}^1\Sigma_u^+$ transition while the M_2 and M_2' bands are associated with a degenerate $^1\Sigma_g^+ \rightarrow {}^1\pi_u$ transition. Particular attention was paid to the influence of the anions and cations of the lattice on the lifting of the degeneracy of the $^1\pi_u$ state. Other experiments involved the thermal bleaching of positive hole (Cl_2^-) centers in KCl and NaCl, the temperature dependence of the shape of the F and M, bands in NaF, NaCl, NaBr, and KI, the nature of the centers responsible for the deep red color of the mineral villiaumite (naturally occurring NaF), and the penetration of H_2O into additively colored KI at room temperature. (auth)

3101 (DEMO-71/3) PHYSICS DEPARTMENT ANNUAL REPORT, 1970. (Democritus Nuclear Research Center, Athens (Greece)). 1971. 109p. Dep. NTIS (U. S. Sales Only).

ALUMINUM — radiation effects on resistivity in, neutron, (E)
— deviation from Matthiessens rule in
ALUMINUM ALLOYS — radiation effects on resistivity in, neutron, (E)
COPPER — deviation from Matthiessens rule in
— radiation effects on electric conductivity of deformed, neutron, (E)
COPPER ALLOYS — radiation effects at 78°K in, neutron, (E)
ELEMENTARY PARTICLES — correlation function between nucleons and, in nuclear matter, (T)
IRON — magnetic aftereffect of dilute solid solutions of carbon in alpha, with manganese and silicon impurities, (E)
MESONS (π) — interactions with pions, low-energy resonances in Veneziano model
NEUTRONS — effects on internal friction in pure silver at 4.6°K, (E)
— effects in copper alloys at 78°K, recovery stages in, (E)
— effects on resistivity in aluminum and aluminum alloys at 78°K, (E)
— effects on electric conductivity of deformed copper, (E)
NUCLEAR MATTER — correlation function between impurity particle and nucleon in, (T)
NUCLEONS — correlation function between impurity particles and, in nuclear matter, (T)
— form factor calculation with a Veneziano-like model, isovector, (T)
PLASMA WAVE PHENOMENA — nonlinear surface waves in vacuum interfaces, (T)
— Doppler effect and group velocity in nonlinear, relativistic, (T)
QUANTUM MECHANICS — axiomatic approach to, set theoretical, (T)
SILVER — radiation effects on, internal friction in pure, neutron, (E) (W.D.M.)

3102 (IAE-2006) INFLUENCE OF HIGH-ENERGY PARTICLE-INDUCED DAMAGE REGIONS ON SEMICONDUCTOR OPTICAL PROPERTIES. Litvinov, V. L.; Ukhin, N. A. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 52p. (In Russian). INIS.
The effect of damaged areas created by high-energy particles on light attenuation was studied in semiconductors. It was concluded that a damaged area in germanium contains a vacancy, in silicon a phethora of divacancies, and in gallium arsenide metallike characteristics. (tr-auth) (INIS)

3103 (ORO-3098-14) RADIATION EFFECTS IN CRYSTALLINE MATERIALS. Final Report. Chaplin, R. L. (Clemson Univ., S. C. Dept. of Physics). [1971]. Contract AT(40-1)-3098. 32p. Dep. NTIS.
Studies were made of the effects of low-energy electron irradiations (up to 0.5 MeV) on Al, Mg, Cu, and Ti. Measurements were made of the rates of defect production, threshold energy for atomic displacements, recovery, and changes in electric resistivity per unit defect concentration. Suggestions for future research are given. (D.L.C.)

3104 (SRARI-P-60) POINT DEFECT COMPLEXES AND THEIR SIZE DISTRIBUTION IN IRRADIATED METALS OF CUBIC

LATTICES. Kirsanov, V. V. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1970. 29p. (In Russian). INIS.

An attempt to classify defects and their agglomeration was made in irradiated cubic metals. From an analysis of the results obtained by model simulation on an electronic computer of the cascades of collisions in cubic metals, and also of experimental results, a distribution law based on the dimensions of the defect complexes (Rayleigh's law) was formulated. The influence of the energy spectrum of the neutron flux was considered. (tr-auth) (INIS)

3105 REACTIVELY SPUTTERED TANTALUM THIN FILM RESISTORS. PART 2. LOW-ENERGY, LOW-FLUENCE PROTON RADIATION DAMAGE. Shewchun, J. (McMaster Univ., Hamilton, Ont.); Hardy, W. R.; Kuenzig, D.; Tam, C. Thin Solid Films; 8: No. 2, 101-15(Aug 1971).

Tantalum thin film resistors reactively sputtered in oxygen and nitrogen simultaneously were bombarded with 150-keV protons to obtain the conductance–fluence characteristics. The conductance of heat-treated films increased as a linear function of fluence at room temperature for values of fluence up to the measured value of 10^{16} p/cm^2. This linear conductance increase may be accounted for by radiation-produced defect levels within the intergranular crystalline oxide regions of the discontinuous films. The rate of conductance change with fluence was a maximum for a total reactive partial pressure in the range of 2×10^{-5} torr, falling off for both greater and smaller total reactive partial pressures. For nonheat-treated films, the conductance increased as a nonlinear function of fluence. This nonlinear increase may be accounted for by defect trapping within the amorphous intergranular oxide. The damage rate as a function of proton beam energy followed the Rutherford law over the range of 50 to 150 keV. (auth)

3106 ELECTRON SPIN RESONANCE OF CONDUCTION ELECTRONS IN PHOSPHORUS-ION-IMPLANTED SILICON. Hasegawa, Seiichi; Kontani, Ryozo; Shimizu, Tatsuo (Kanazawa Univ., Japan). Jap. J. Appl. Phys.; 10: No. 11, 1641-2 (Nov 1971).

A study was made of the ESR signal of conduction electrons in Si implanted with P^+ ions at 100 or 200 keV and annealed above 600°C. The variations of the line width with annealing temperature, measurement temperature, and depth of surface layer removal were measured. The width decreases suddenly at 1500–2000 and 3500 Å for the 100- and 200-keV implantations, respectively. The spin density variation was found to be less sudden. The origin of the width decrease is considered to be deformation of the surface layer and/or the remaining imperfections. (D.L.C.)

3107 MODIFICATION OF MAGNETIC ANISOTROPY IN GARNETS BY ION IMPLANTATION. Wolfe, R.; North, J. C.; Barns, R. L.; Robinson, M.; Levinstein, H. J. (Bell Telephone Labs., Murray Hill, N. J.). Appl. Phys. Lett.; 19: No. 8, 298-300(15 Oct 1971).

Ion implantation into epitaxial films of certain magnetic garnets grown on nonmagnetic substrates produced layers with uniaxial anisotropy suitable for magnetic "bubble" formation and propagation. Implantation of hydrogen or lithium ions causes the garnet lattice to expand, and the constraint of the unimplanted material places the implanted layer in lateral compression. In garnets with positive magnetostriction, this stress results in an induced easy axis of magnetization perpendicular to the surface. Helium-ion implantation does not cause lattice expansion or induce magnetic anisotropy. This suggests that the phenomenon is due to a chemical effect rather than lattice damage. (auth)

3108 SOLID STATE DEVICES. Proceedings of the 2nd Conference, Tokyo, September 21–22, 1970. J. Jap. Soc. Appl. Phys.; 40: Suppl., 1-250(1971). (CONF-700959).

Thirty-nine papers are included, covering such topics as ion implantation, doping, various junctions and devices, bulk effect, photoelectric devices, MOS devices, microwave devices, etc. Separate abstracts were prepared for four papers dealing with ion implantation damage and radiation-enhanced diffusion. (D.L.C.)

For abstracts of individual papers see: 3109–3112.

3109 VACANCY DISTRIBUTION THEORY FOR ION-IMPLANTED TARGET. Furukawa, Seijiro; Ishiwara, Hiroshi (Tokyo Inst. of Tech.). J. Jap. Soc. Appl. Phys.; 40: Suppl., 3-8(1971).

From second conference on solid state devices; Tokyo, Japan (21 Sep 1970).

Analytical considerations are presented on the distribution of lattice vacancies produced by both implanted ions and energetic recoil atoms. Under proper assumptions, the depth distribution of the vacancies was calculated for 50-keV Sb implantations in Si. Special features in the results are: (1) the vacancy distribution has a maximum value at a depth shallower by about 1/3 than a depth where the impurity distribution has a maximum value; (2) the target will become amorphous at a dose greater than 8.7×10^{13} ions/cm^2; and (3) each Sb ion will displace about 1700 Si atoms. (auth)

3110 ELECTRON MICROSCOPIC STUDY OF CRYSTAL DEFECTS IN BORON- AND PHOSPHORUS-IMPLANTED SILICON. Tamura, M.; Ikeda, T.; Yoshihiro, N. (Hitachi, Ltd., Tokyo). J. Jap. Soc. Appl. Phys.; 40: Suppl., 9-15(1971).

From second conference on solid state devices; Tokyo, Japan (21 Sep 1970).

Transmission-electron-microscopic observations were conducted on boron- and phosphorus-implanted silicon substrates as a function of implantation and subsequent annealing conditions. Depth distribution and character of crystal defects introduced by implantation treatment were investigated. Dislocation networks were formed in both boron- and phosphorus-implanted layers (1×10^{16}/cm^2 dose) annealed at 1000°C for 60 min, and at 800°C for 1000 min, respectively. These phenomena suggested that implanted ions occupied substitutional sites in the silicon crystal after such annealing treatment. The properties and distribution of defects were also compared with such electrical properties as carrier concentration profile, carrier mobility, and diffusion length of minority carriers. (auth)

3111 RADIATION-ENHANCED DIFFUSION AND ITS APPLICATION TO DEVICE FABRICATION. Abe, Toshio; Ohmura, Yamichi; Konaka, Masami; (and others) (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). J. Jap. Soc. Appl. Phys.; 40: Suppl., 16-23(1971).

From second conference on solid state devices; Tokyo, Japan (21 Sep 1970).

A new technique, Radiation Enhanced Diffusion (RED), of impurity from n^+ silicon substrates to n^- silicon epitaxial layers by proton irradiation, was developed. A high-dose-level (~10^{18}/cm^2) proton beam accelerated up to 350 kV was injected into n^- on n^+ silicon epitaxial wafers with heavily antimony-doped substrates at 800 to 1000°C. After RED, the impurity profile showed that a sharp step-like n^+ protrusion was pushed up from n^+ substrates into n^- epitaxial layers. Impurity profiles of antimony and phosphorus in silicon after RED are discussed in connection with the estimated range and distribution of vacancies generated by protons. Applications of this new technique to the fabrication of high-performance silicon devices, e.g. high-power gain microwave transistors, are discussed. (auth)

3112 ION-IMPLANTED MOSFET. Nishimatsu, Shigeru; Natsuaki, Nobuyoshi; Warabisako, Terunori; Tokuyama, Takashi (Hitachi Ltd., Tokyo). J. Jap. Soc. Appl. Phys.; 40: Suppl., 29-35(1971).

From second conference on solid state devices; Tokyo, Japan (21 Sep 1970).

Damage accompanying boron implantation into MOS structures was investigated by C–V measurement, infrared absorption, and ESR measurement. Annealing effects on the damage were also investigated. Implanted ions in SiO_2 generate positive charges which are annealed out above 250°C. Ions which reached the silicon substrate through the SiO_2 generate a large number of fast states at the Si/SiO_2 interface. These interface states cannot be annealed out up to 530°C and enhance the noise of MOSFETs. Silicon-gate self-aligned MOSFETs were fabricated by boron implantation to form source and drain regions with highly boron-doped polycrystalline silicon as a mask. Threshold voltages of p-channel MOSFETs fabricated by this method were in the range of about –1 V. B^+ ions were also implanted in gate regions of MOSFETs in which source and drain were already fabricated by boron diffusion. With this method, p-channel depletion type MOSFETs were obtained. (auth)

3113 EFFECTS OF IONIZING RADIATIONS ON DIELECTRIC MATERIALS. Coelho, R. (Centre National de la Recherche Scientifique, Paris). Rev. Gen. Elec.; 80: No. 7-8, 601-12(Jul-Aug 1971). (In French).

The various work undertaken on behalf of the Ministere du Developpement Industriel et Scientifique during the last ten years is examined. The most important problems are defined, and the processes involved in interactions between radiations and insulating materials are discussed in the framework of recent theories. The principal results obtained at the L.C.I.E. are reviewed, and the idea of associating them with a damage criterion is considered. The opportunity for studying certain fundamental processes not yet well understood is examined. Certain recent, very interesting, results on radiation-excited currents are discussed; these results have led to the proposal of certain new research projects. (France)

3114 ENERGY LOSSES OF FAST CHANNELED IONS. Kumakhov, M. A. (Moscow State Univ.). Phys. Lett.; 37A: No. 2, 153-4(8 Nov 1971).

A statistical theory of channeled-ion stopping is proposed. Simple analytical formulas for energy losses were obtained. (auth)

3115 INFLUENCE OF SCATTERING ON MeV He^+ CHANNELING IN Si OVERLAID BY AMORPHOUS FILMS. Rimini, E.; Lugujjo, E.; Mayer, J. W. (California Inst. of Tech., Pasadena). Phys. Lett.; 37A: No. 2, 157-8(8 Nov 1971).

MeV He^+ channeling measurements on ⟨110⟩ Si covered with Al and Au layers indicate that minimum yield follows plural and multiple scattering calculations. The rate of dechanneling and angular dependence of the yield differs in the two scattering regimes. (auth)

3116 CHARGE-TRANSFER LUMINESCENCE OF Cr^{3+} IN MAGNESIUM OXIDE. Chao, C.-C. (Univ. of Minnesota, Minneapolis). J. Phys. Chem. Solids; 32: No. 11, 2517-28(Nov 1971).

Cr^{3+} impurity ions were positively identified as one of the activators contributing to the thermoluminescence in MgO. It was found that, in undoped MgO crystals, the major mechanism for Cr^{3+} x-ray fluorescence is a reaction between free holes and Cr^{2+} ions, i.e., free hole + $Cr^{2+} \rightarrow Cr^{3+*}$, $Cr^{3+*} \rightarrow Cr^{3+} + h\nu$. The same mechanism produces the Cr^{3+} thermoluminescence in MgO. The free holes in thermoluminescence come from the destruction of V_1 centers. The destruction of V_1 centers is the rate-determining step for the thermoluminescence and it follows first-order kinetics. The activation energy of the thermoluminescence is 0.80 ± 0.02 eV. (auth) (UK)

3117 ELECTRON PARAMAGNETIC RESONANCE AND OPTICAL STUDIES OF MONOVALENT MANGANESE CENTER IN NaCl. Ikeya, M.; Itoh, N. (Nagoya Univ., Japan). J. Phys. Chem. Solids; 32: No. 11, 2569-79(Nov 1971).

EPR and optical absorption spectra of the Mn^+ center in NaCl are studied. The EPR spectrum of Mn^+ at K-band frequency has a hyperfine coupling constant of $A = (231 \pm 1) \times 10^{-4}$ cm^{-1} and an isotropic g-value of 1.9992 ± 0.0005. Fine structures caused by second-order hyperfine interaction at X-band frequency are analyzed by diagonalizing the matrix of the spin Hamiltonian that contains the Zeeman and the hyperfine terms. Shf structures are also observed for the magnetic field along ⟨111⟩. The temperature dependence of the hyperfine coupling constants of Mn^{2+}, Mn^+, and Mn^0-C is measured and explained by using the theoretical formula based on the phonon-induced hyperfine coupling. It is concluded that the Mn^+ ion is located at the Na^+ site. An optical absorption band at 4.47 eV is ascribed to the transitions from the ground state $3d^54s(^7S)$ to the excited states $3d^54p(^7P)$ of the Mn^+ ion. Mn^+ ions are produced when the Mn^0 atom traps a positive hole or when the Mn^{2+} traps an electron. (auth) (UK)

3118 SIMULATION OF A MODEL OF SATURATION OF ALKALI HALIDE CRYSTALS WITH F CENTRES. Herrmann, F.; Pinard, P. (Institut National des Sciences Appliques, Lyon). J. Phys. Chem. Solids; 32: No. 11, 2649-52(Nov 1971).

A Monte Carlo method was used to simulate colour-centre growth curves, and simulated experiments were carried out in one and three dimensions. The simulation yielded a growth curve in close agreement with those obtained experimentally at growth temperature by electron irradiation. Modifications of the present form of the model are suggested. (UK)

3119 THERMAL DECAY OF THE V_{OH} CENTER IN MgO. Kappers, Laurence A.; Wertz, John E. (Univ. of Minnesota, Minneapolis). Solid State Commun.; 9: No. 20, 1755-8(15 Oct 1971).

The concentration of V^- centers (a positive hole trapped at a cation vacancy) in MgO is observed to increase during the thermal decay of the related V_{OH} centers at 20°C. This shows (at least for V_{OH}) that, in the decay process at room temperature, hole release predominates over annihilation by electrons released from other centers. (auth) (UK)

3120 ELECTRONIC STRUCTURE OF hcp YTTERBIUM. Jepson, O. (Technical Univ., Lyngby, Denmark); Anderson, O. K. Solid State Commun.; 9: No. 20, 1763-7(15 Oct 1971).

The energy bands and Fermi surface of hcp ytterbium were calculated by the relativistic APW method. The results are in good agreement with recent de Haas–van Alphen data. A new procedure for the calculation of cross-sectional areas and other geometrical properties of the Fermi surface is presented. (auth) (UK)

3121 SPATIAL DISTRIBUTION OF CHANNELLED IONS. Van Vliet, Dirck (Chalmers Univ. of Tech., Goteborg). Radiat. Eff.; 10: No. 3, 137-55(Aug 1971).

The spatial distribution of channelled ions in the transverse plane is studied theoretically, using models based on the continuum approximation and confirmed by computer simulation. The variation of the flux across the crystal channels is found to be quite pronounced. In particular, the averaged flux at the centre of the channel can be as high as 4 or 5 times normal under experimentally attainable conditions or, due to the oscillatory nature of channelled trajectories, even greater at certain fixed depths. The dependence of the maximum flux on the multiple scattering and the channel geometry is examined in detail. A general expression for the flux at any point in the transverse plane is derived, and various simplifications are introduced that take advantage of the symmetry about either the atomic rows or the mid-channel axes. Both the ideal situation as well as perturbations due to misalignment and multiple scattering are treated. The results have a direct application to any channelling experiment which measures an interaction that is sensitive to the position of the target atoms, in particular atom location studies and the flux-peaking effect. (auth) (UK)

3122 FOURIER APPROACH TO DIFFUSION–NUCLEATION CALCULATIONS FOR THIN FOILS. Goringe, M. J. (Oxford Univ.). Radiat. Eff.; 10: No. 3, 169-74(Aug 1971).

The theory of diffusion and nucleation of Brown, Kelly and Mayer [Phil. Mag., 19: 721(1968)] is extended to the case of thin foils by expressing all the quantities involved as Fourier series. The method is then applied to the situation encountered during in-situ electron-irradiation experiments in high-voltage electron microscopes. The results show how measurements of loop densities may be corrected for the effects of the surfaces and suggest areas for further experimental observations. (auth) (UK)

3123 COPPER SINGLE-CRYSTAL SPUTTERING IN THE TEMPERATURE RANGE FROM 50 TO 600K. Elich, J. J. Ph.; Roosendaal, H. E.; Onderdelinden, D. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Radiat. Eff.; 10: No. 3, 175-84(Aug 1971).

Measurements are performed on the dependence of the sputtering ratio of monocrystalline copper on the target temperature, for bombardment on (100), (110), and (111) crystals with 20-keV Ar^+ or Ne^+ ions at normal incidence. The target temperatures are varied roughly from 50 to 600°K. These bombardments along a low index direction are compared with bombardment in an opaque direction. A model is sketched to calculate the influence of the thermal vibrations on the channeling effect. Two effects are considered: broadening of the string and blocking of the channel. It leads to an expression for the fraction of the ion beam that dechannels as a function of the depth. Assuming an expression for the sputtering efficiency from a certain depth in the crystal, the sputtering ratio can be calculated. In the case of the (100) and (110) crystals, the calculations agree reasonably well with the measurements. Comparing calculation and experiment, it can be concluded that the maximum depth responsible for sputtering decreases with increasing temperature. For the (111) direction, no satisfactory description according to the sketched model can be given. This can be explained by the relatively narrow [111] channels. (auth) (UK)

3124 ELECTRICAL PROPERTIES OF 60-keV ZINC IONS IMPLANTED INTO SEMI-INSULATING GALLIUM ARSENIDE. Littlejohn, M. A.; Hauser, J. R.; Monteith, L. K. (North Carolina State Univ., Raleigh). Radiat. Eff.; 10: No. 3, 185-90 (Aug 1971).

The electrical properties of chromium-doped semi-insulating GaAs implanted with 60-keV zinc ions were studied. Hall-effect measurements show that the implanted layer is p-type, even in unannealed layers implanted at room temperature. There, the measured Hall mobilities are less than 1 cm^2/volt sec. Upon annealing to temperatures as high as 400°C, there is a dramatic increase in both the sheet resistivity and Hall mobility for ion doses between 10^{12} and 3×10^{14} cm^{-2}. At higher annealing temperatures up to 800°C, the Hall mobility saturates at values near 100 cm^2/volt sec for doses in the above range. At the same time, the sheet resistivity decreases drastically, yielding effective surface concentrations near the total dose. For a dose of 1×10^{15} cm^{-2}, the Hall mobility as a function of annealing temperature behaves essentially the same as for the lower doses. However, the sheet resistivity behaves quite differently. Instead of the initial annealing stage, the sheet resistivity monotonically decreases with annealing temperature, and at 800°C yields effective surface concentrations of less than 10% of the total dose. The differences observed in the annealing of sheet resistivity between the doses

of 3×10^{14} cm^{-2} and 1×10^{15} cm^{-2} are taken as evidence that the amorphous threshold lies between these values. Finally, some measurements of sheet resistivity and mobility as a function of measurement temperature suggest that deep-lying defect centers probably dominate the electrical properties of the zinc implanted layers at all annealing temperatures up to 800°C. (auth) (UK)

3125 ANNEALING OF PARAMAGNETIC DIVACANCIES IN FAST-NEUTRON-IRRADIATED SILICON. Daly, D. F.; Noffke, H. E. (Bell Telephone Labs. Inc., Whippany, N. J.). Radiat. Eff.; 10: No. 3, 191-5(Aug 1971).

An isochronal annealing study was made of the paramagnetic divacancy in p-type silicon. This damage spectrum was produced by fast-neutron irradiation, which produces damage clusters. The paramagnetic divacancies are shown to anneal at a much higher temperature than the divacancies responsible for infrared absorption in neutron-irradiated silicon. The paramagnetic divacancy concentration is fitted to annealing equations with 3 to 7×10^{17} "sinks"/cm^3 for divacancies. The divacancy infrared absorption can only be fitted to a special annealing equation with 2×10^{21} "sinks"/cm^3. These results provide evidence that the paramagnetic divacancy is outside the damage core of the cluster while the infrared absorption is due to rapidly annealing divacancies inside the heavily damaged core. This supports the damage cluster model for neutron-irradiated silicon. (auth) (UK)

3126 V_{OH} CENTRE IN STRONTIUM OXIDE. Blake, W. B. J.; Gitelson, H. A.; Wertz, J. E. (Univ. of Minnesota, Minneapolis). J. Phys., C (London); 4: No. 13, L261-3(17 Sep 1971).

A hydrogen-containing trapped hole center (V_{OH}) was identified from its ESR spectra in x-irradiated strontium oxide crystals. ENDOR studies confirmed the nature and geometry of the center as similar to that in MgO and in CaO. The g components $g_{||}$ = 2.0010 (3) and $g_{\perp}$ = 2.0750 (3) are similar to those for CaO. (auth) (UK)

3127 KINETICS OF REORIENTATION OF OPTICALLY ORIENTED V_K CENTERS AND OF THERMAL ANNIHILATION OF NH_3Cl CENTERS IN IRRADIATED AMMONIUM CHLORIDE. Byrd, James Cozby Jr. Clemson, S. C.; Clemson Univ. (1971). 133p. University Microfilms Order No. 71-25,608.

Thesis.

Electron spin resonance was used to study the kinetics of thermal annihilation of radiation-induced NH_3Cl color centers in single-crystal NH_4Cl. A separate spin resonance study was devoted to the kinetics of thermal reorientation of optically oriented V_K centers, or self-trapped holes, in NH_4Cl. The spin resonance spectrum of both species of defect is well-known. Advantage was taken of the fact that the amplitude of the spin resonance signal can furnish information regarding both the relative numbers and the orientations of the centers within the crystal lattice. NH_3Cl centers were produced by irradiating the sample with x rays 180°K. Elevation of sample temperature above 225°K resulted in rapid thermal annihilation of the centers. A series of isothermal annealing experiments in the temperature range 233 to 253°K showed that the activation energy for thermal annihilation of NH_3Cl centers is 1.2 ± 0.2 eV. This was interpreted as being the activation energy for the decomposition of the NH_3Cl color center by the two competing processes: $NH_3Cl \rightarrow NH_2^+ + Cl^- + H^0$ $NH_3Cl \rightarrow NH_3^0 + Cl^- + H^+$, a mechanism suggested by Marquardt. V_K centers were produced by irradiating the crystal sample with x rays at an irradiation temperature of 105°K. When first produced, the V_K centers have random orientations in the three crystallographic ⟨100⟩ directions. Irradiation for 15 minutes with unpolarized ultraviolet light, at about 105°K, resulted in a change of orientation of some of the centers, a process called optical orientation. In an optical orientation, the population of centers lying along one of the ⟨100⟩ directions is enhanced at the expense of the others. A series of isothermal anneals in the temperature range 120 to 140°K showed that thermal reorientation, in which the centers move back to random orientations, is accompanied by thermal annihilation. The activation energy for the process was found to be 0.38 ± 0.05 eV. A possible interpretation of the results is that, in NH_4Cl, self-trapped holes move through the lattice by means of long-range jumps. (Diss. Abstr. Int., B)

3128 POSITRON ANNILHILATION CENTERS IN ALKALI HALIDES. Waung, Hsi Fong. New York; New York Univ. (1971). 96p. University Microfilms Order No. 71-24,772.

Thesis.

The complexity of positron lifetime spectra in alkali metal halide crystals is related experimentally to the defect structure in single crystals. The data support the mechanism, proposed by W. Brandt, which is characterized by four processes: (1) in the perfect crystal a thermalized positron annihilates at the rate γ_c; (2) in competition with (1), the positron can be trapped by a defect at the rate κ to form an annihilation or A center; (3) once the A center is formed, the positron annihilates at a rate γ_a; and (4) in competition with (3), the positron can escape from the A center at the rate λ which must be small compared to γ_a. The experiments show that the intensity of the dominant long-lived component in the positron lifetime spectrum of NaCl decreases with increasing coloration induced by x rays. Specifically, V-center formation suppresses A-center formation. In KCl crystals doped with Ca^{2+}, the intensity of the longest-lived component in the lifetime spectrum is found to increase in such a manner that κ grows proportional to the square root of the Ca concentration, a relation expected to hold if the concentration of defects operable as A centers increases as the concentration of positive ion vacancies introduced into the crystals by Ca^{2+} doping to preserve charge neutrality. These observations support the idea that positrons trapped in A centers form the antimorphs to electrons trapped in F color centers, and that hole trapping renders potential A centers inoperable as positron traps. Changes in the positron lifetime spectra caused by plastic deformation of the crystals are in accord with these conclusions. The results suggest that positron annihilation measurements can serve as an important complement to color-center measurements in the study of defects in ionic crystals. (Diss. Abstr. Int., B) (U.S. INIS)

3129 DETERMINATION OF SENSITIVITY OF THE THERMOPHOSPHOR $CaSO_4$–Mn TO ELECTRONS WITH ENERGY 0.1 TO 15 keV. Kazachevskaya, T. V.; Kovalenko, V. G.; Selant'ev, V. V.; Polenov, B. V. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 2, 294-5(Mar-Apr 1971).

Translated from Kosm. Issled.; 9: No. 2, 317-18(Mar-Apr 1971).

Plates with $CaSO_4$–Mn deposited on them were irradiated in a special vacuum chamber (10^{-6} mm Hg) and then deexcited by heating in front of a FEU-35 photomultiplier. The percentage energy yield P was $\sim 5.10^{-4}$ % for E_e = 100 eV. It increased with increasing electron energy to 3.3% for E_e = 10 keV and remained practically constant up to 15 keV. (W.D.M.)

3130 GLOW CURVES OBTAINED BY IONIZING AND NON-IONIZING RADIATION. Kristianpoller, N.; Israeli, M. (Tel-Aviv Univ., Israel). Phys. Status Solidi (b); 47: No. 2, 487-93 (1 Oct 1971).

Two distinct groups of glow peaks were recently observed in nominally pure, uv-excited alkali halides. These glow peaks are compared with those obtained by x-irradiation. Different processes are assumed to be responsible for the excitation of the thermoluminescence (TL) emitted at the various peaks. One process, associated with the creation of Frenkel pairs, causes the excitation of TL by uv light in the region of the first exciton band. This process appears also to be dominant in the excitation of "virgin" pure samples by x rays. Another process is involved in the excitation of TL by ionizing uv light. This excitation, restricted in this case to a thin surface layer, is attributed to the presence of oxygen impurities and the generation of V_K centers. (auth)

3131 RADIATION DAMAGE OF GALLIUM ARSENIDE BY HEAVY IONS. Pritchard, W. M. (Old Dominion Univ., Norfolk, Va.). Trans. Amer. Nucl. Soc.; 14: No. 2, 574(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3132 ELECTRON TRAPPING IN METAL OXIDES CAUSED BY HIGH RADIATION FIELDS. Pickard, P. S. (Univ. of Arizona, Tucson); Myers, G. E.; Davis, M. V. Trans. Amer. Nucl. Soc.; 14: No. 2, 574-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Physical Properties

Refer also to abstracts 2536, 2614, 2624, 2934, 3501, and 3507.

3133 (DEMO-70/8) PHYSICS DEPARTMENT ANNUAL REPORT, 1969. Kouris, C. B. (ed.) (Democritus Nuclear Research Center, Athens (Greece)). 1970. 71p. Dep. NTIS (U. S. Sales Only).

COPPER — radiation effects on electric resistivity of, recovery spectra from fast-neutron

FERROMAGNETIC MATERIALS — after-effects in, apparatus for measurement of

IONOSPHERE — sporadic E, unusual night-time occurrence of, following March 23, 1969 magnetic storm

IRON — radiation effects on, with and without carbon additions, recovery spectra from fast-neutron

MAGNETIC STORMS—waves during onset of Mar. 23, 1969, horizontal traveling
MESONS (π)—interactions $\pi + \pi$, calculation of elastic scattering amplitude with nonlinear Lagrangian
MOLYBDENUM FERRATES—crystallography of $MoFe_2O_4$, (E)
NEUTRONS, FAST—effects on electric resistivity of copper, iron, nickel, and platinum, recovery spectra from
NICKEL—radiation effects on electric resistivity of, recovery spectra from fast-neutron
NUCLEONS—interactions γ + N, pseudoscalar meson production and Compton effect with polarized photons, (E/T)
PHOTONS—interactions γ + N, pseudoscalar meson production and Compton effect with polarized, (E/T)
PLATINUM—radiation effects on electric resistivity of, recovery spectra from fast-neutron
SPINELS—crystallography of $MoFe_2O_4$, (E) (L.M.T.)

3134 (NYO-2150-75) LATTICE THERMAL CONDUCTIVITY AND HIGH-FIELD ELECTRICAL AND THERMAL MAGNETOCONDUCTIVITIES OF TUNGSTEN. Report No. 1577. Wagner, D. K. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Jun 1971. 52p. Dep. NTIS.

Results of measurements of the high-field transverse electric and thermal conductivities, σ_{xx} and κ_{xx}, of a high-purity tungsten single crystal are presented for the temperature range 1.5 to 6°K. The magnetic field dependences of the conductivities conform excellently to the predictions of high-field semiclassical magnetoresistance theory, provided thermal conduction by the lattice is taken into account. The results show that the lattice thermal conductivity is proportional to T^2, as expected for a pure metal in which the phonons are scattered principally by the conduction electrons. The temperature dependence of the high-field electric conductivity σ_{xx}, and the corresponding electronic contribution $(\kappa_e)_{xx}$ to the thermal conductivity κ_{xx} were also measured. Theoretical expressions for these quantities are derived from semiclassical magnetoresistance theory, allowing estimates to be made of the temperature dependence associated with possible low-temperature scattering mechanisms. Difficulties in interpreting previous zero-field measurements in terms of electron–electron or electron–phonon scattering are discussed. (auth)

3135 (NYO-3828-10) EXPERIMENTAL STUDIES OF CRITICAL POINT BEHAVIOR IN MAGNETICALLY ORDERED SOLIDS USING NUCLEAR GAMMA-RAY SPECTROSCOPY, AND RELATED EXPERIMENTS. Final Report, February 1, 1967–July 20, 1971. Hohenemser, Christoph (Brandeis Univ., Waltham, Mass. Dept. of Physics). Contract AT(30-1)-3823. 22p. Dep. NTIS.

In four and one-half years of research on ferromagnetic critical phenomena, it was demonstrated that the time-dependent perturbed angular correlation (TDPAC) technique can be used to obtain precise information on both static and dynamical aspects of the critical point. Work on nickel provided two instances of unique contributions by the TDPAC technique. These were the precise measurement of β, the critical exponent, and critical fluctuation measurements on ^{100}RhNi. Neither of these could have been done as well in any other way, and both have a considerable impact on the field of critical phenomena. Future experiments utilizing the TDPAC technique are discussed. (L.M.T.)

3136 QUENCH-AGING OF NIOBIUM–HYDROGEN ALLOYS AT -196°C. Sasaki, Yasuo; Amano, Muneyuki (National Research Inst. for Metals, Tokyo). Kinzoku Zairyo Gijitsu Kenkyusho Kenkyu Hokoku; 14: No. 2, 72-4(1971). (In Japanese).

A decrease in electrical resistivity of niobium–hydrogen alloys is observed during the isothermal aging at −196°C. It is shown that the aging process is a reaction with the time exponent of $\frac{1}{3}$ and the activation energy of 0.10 ± 0.02 eV. A change in flow stress is also observed with the aging at this temperature. These phenomena are not found in hydrogen-free niobium. It is suggested that the changes in resistivity and flow stress should be attributed to the hydride precipitation at −196°C. (auth) (Japan)

3137 EFFECTS OF TEMPERATURE ON THE MAGNETIC HYPERFINE PROPERTIES OF BERYLLIUM. Jena, P. (State Univ. of New York, Albany); Das, T. P. Phys. Rev., B; 4: No. 11, 3931-4(1 Dec 1971).

The temperature dependence of the Fermi contact and exchange core-polarization (ECP) contribution to Knight shift K and nuclear-spin relaxation time T_1 in beryllium was studied. The variation in the spin density shows a similar trend to that in cadmium, namely, the s content of the conduction-electron wave function Ψ_k increases with temperature at the expense of a decrease in the p content. Combining both direct and ECP contributions, K increases by 2.3% and T_1T decreases by 8% from 0 to 300°K. The results are compared with the available experimental data. (auth)

3138 MAGNETO-ELASTIC DEPENDENCE OF PROPAGATION OF SOUND IN GADOLINIUM AT THE CRITICAL POINT. Long, M. Jr.; Stern, R. (Univ. of California, Los Angeles). Phys. Rev., B; 4: No. 11, 4094-9(1 Dec 1971).

The changes in the attenuation of sound and in the elastic constant c_{33} of gadolinium were measured at 5 MHz as functions of applied magnetic fields to 13 kOe in the temperature range 270 to 320°K. The minimum in the elastic constant at the Curie point moved upwards in temperature and tended to diminish and broaden with increasing field. Studies of the change in attenuation due to magnetic field in the same region revealed sharp λ-shaped increases up to a field of 1.8 kOe. At higher fields, this peak split into two diminishing maxima, one moving upwards and the other downwards with increasing field. The zero-field-attenuation data decreased as $\Delta\alpha \sim \epsilon^y$, where $\epsilon = |(T - T_c)/T_c|$ and $y = -1.8 \pm 0.2$ in the paramagnetic region. In the presence of a magnetic field, the changes in the velocity are attributed to changes in the spin-correlation function. (auth)

3139 DEPENDENCE OF RESISTANCE ON PRESSURE IN c DIRECTION OF PYROLYTIC AND NATURAL GRAPHITE. Okuyama, Naoki (Tokyo Univ.); Yasunaga, Hitoshi; Minomura, Shigeru; Takeya, Kenichi. Jap. J. Appl. Phys.; 10: No. 11, 1645-6(Nov 1971).

The pressure dependence of the resistivity in the c direction of various pyrolytic graphites and Madagascar natural graphite was measured. Below 100 kbar, all the samples had the same pressure coefficient, $d \ln \sigma_c / dP = 0.011$ kbar^{-1}. Above 100 kbar, the resistance decreases monotonically for some of the pyrolytic graphites, but it exhibits an abrupt rise around 160 kbar for the other pyrolytic graphite and natural graphite. A plot of relative resistance R_c/R_{co} vs relative lattice constant c/c_0 shows a linear relation $R_c/R_{co} = 6.40\ c/c_0 - 5.40$ below 100 kbar. (D.L.C.)

3140 MAGNETIC SUSCEPTIBILITIES OF ThM_2X_2 COMPOUNDS (M = Cr, Mn, Fe, Co, Ni, AND Cu; X = Si AND Ge). Omejec, L.; Ban, Z. (Inst. Rudjer Boskovic, Zagreb. Inst. for Inorganic and Analytical Chemistry, Zagreb). Z. Anorg. Allg. Chem.; 380: No. 1, 111-17(Jan 1971).

Magnetic susceptibilities of a series of ternary intermetallic compounds of the general composition ThM_2X_2 (M = Cr, Mn, Fe, Co, Ni, and Cu; X = Si and Ge) were determined by means of the Faraday method in the temperature interval 100 to 570°K. The results confirm the previously proposed magnetic behavior of these compounds, based on the observation of the basic crystallographic parameters as a function of the atomic number of the transition metal element. The compounds were found to be alternatively ferromagnetics and antiferromagnetics depending on the atomic number of the transition metal atom. (auth)

3141 MAGNETIC BREAKDOWN IN BERYLLIUM. Alekseevskii, N. E.; Slutskin, A. A.; Egorov, V. S. (Inst. for Physical Problems, Moscow). J. Low Temp. Phys.; 5: No. 4, 377-95 (Oct 1971).

Data on the magnetoresistance of Be over a wide range of fields and temperatures are discussed, and a theoretical analysis is given of the kinetic characteristics acquired by the electrons due to magnetic breakdown. Attention is focused on the coherence affiliated with magnetic breakdown. (D.L.C.)

3142 RESISTIVITY OF α-MANGANESE AND SOME OF ITS TRANSITION-METAL ALLOYS. Whittaker, K. C.; Dziwornooh, P. A. (Univ. of Science and Tech., Kumasi, Ghana). J. Low Temp. Phys.; 5: No. 4, 447-64(Oct 1971).

Resistivity measurements were carried out on α-manganese and some of its transition metal alloys between 2 and 273°K. A resistance minimum, a notable characteristic of α-manganese, was observed, in agreement with other workers, and found to be very dependent on a second constituent in α-manganese. The temperature T_{min} at which the resistance minimum occurs was shifted to lower values by lower-valency additions chromium and vanadium and to higher values by higher-valency additions iron, cobalt, and nickel and also by rhenium with the same valency as manganese. A discontinuity in the temperature coefficient of the resistance was also observed in some of our samples at a temperature a little higher than T_{min}. (auth)

3143 REACTIVELY SPUTTERED TANTALUM THIN FILM RESISTORS. PART 1. PHYSICAL AND ELECTRICAL PROPERTIES. Hardy, W. R. (McMaster Univ., Hamilton, Ont.); Shewchun, J.; Kuenzig, D.; Tam, C. Thin Solid Films; 8: No. 2, 81-100(Aug 1971).

Tantalum thin-film resistors were reactively sputtered in oxygen and nitrogen simultaneously. The films studied had TCR values ranging from −50 to −900 ppM/°C. The corresponding resistivities

ranged from 400 to 3×10^4 $\mu\Omega$ cm. The dual dopant scheme of nitrogen plus oxygen produces a higher resistivity for a given TCR than has been previously reported for a dopant of either oxygen or nitrogen. The electrical-conduction mechanism may be explained on the basis of an activated tunneling mechanism and a metallic conduction mechanism acting simultaneously. Electron-microscopy results demonstrate that the structure of the as-deposited films consists of metallic islands largely surrounded by amorphous Ta_2O_5. Heat treatment of these films in air produces a stabilizing surface oxide, in addition to producing a crystallization of the intergranular Ta_2O_5. (auth)

3144 PROPERTIES OF HIGH Co–Fe–Nb SEMIHARD MAGNETIC ALLOYS. Okada, Masanori; Kassai, Makoto; Suzuki, Yuichi; Sasaki, Tatsuji; Henmi, Zenzo (Fujitsu Labs., Ltd., Kawasaki, Japan). J. Jap. Inst. Metals; 35: No. 9, 942-6 (Sep 1971). (In Japanese).

The effect of chemical composition on properties was investigated in high Co–Fe–Nb semihard magnetic alloys. Magnetic properties, resistivity, Vickers hardness, x-ray diffraction, and thermal expansion were measured in the specimens annealed at 500 to 1100°C after cold drawing by 90% reduction in area. The coercive force (H_c) of the specimen with Nb was remarkably increased by the annealing near 700°C and the value of the alloy with 4 wt % Nb reached about 30 Oe. Moreover, a squareness ratio (I_n/I_{100}) higher than 0.90 and a magnetization ($4\pi I_{100}$) about 16000 G were obtained. The values of squareness ratio and remanence of specimens containing more than 15 wt % Fe in the cold drawn state were low. However, the values increased with the annealing temperature and reached over 0.90 and 14500 G by 700°C annealing, respectively. The crystal structure of Co–21 wt % Fe–3 wt % Nb alloy in the cold drawn state was bcc and transformed to the fcc phase by annealing above 900°C. (auth)

3145 MOLYBDENUM WORK FUNCTION DETERMINED BY ELECTRON EMISSION MICROSCOPY. Jacobson, Dean L.; Campbell, Albert E. (Electro-Optical Systems, Pasadena, Calif.). Met. Trans.; 2: No. 11, 3063-6(Nov 1971).

A polycrystalline molybdenum sample was recrystallized and thermally stabilized. Quantitative measurements of the emission from each individual grain were obtained with an electron emission microscope. The effective work function for each grain was then calculated. The crystallographic orientation of each grain was determined by Laue back-reflection techniques. A polar plot of effective work function vs crystallographic orientation for the sample was constructed to provide a correlation between effective work function and crystallographic orientation. (auth)

3146 MAGNETIC ANISOTROPY OF A SEMIHARD MAGNETIC ALLOY OF Co–Fe–Nb SYSTEM. Kassai, Makoto; Okada, Masanori; Sasaki, Tatsuji; Henmi, Zenzo (Fujitsu Labs., Ltd., Kawasaki, Japan). J. Jap. Inst. Metals; 35: No. 8, 745-50(Aug 1971). (In Japanese).

The relationship between the crystalline texture and the magnetic anisotropy in the Co–12 Fe–3 Nb alloy cold-rolled by 96% reduction in area was investigated through the measurements of x-ray pole figures, hysteresis loops, and magnetic torque curves. The results obtained are summarized as follows: (1) The magnetic anisotropy of this alloy is due to the magnetic crystal anisotropy (K_1) and the induced magnetic anisotropy (K_u). The shape of the hysteresis loop depends on which anisotropy is prevailing; perminvar type for $K_u > K_1$, constricted curve for $K_u = K_1$, and rectangular curve for $K_u < K_1$. (2) In the cold-rolled and annealed states, the direction of major easy magnetization is along the transverse direction. (3) Upon annealing at temperatures above 700°C, the direction of hard magnetization changes to that of minor easy magnetization. (4) The cold-rolling texture of this alloy is the "brass-type" one, that is, (110)[$\bar{1}$12]. This texture persists up to 900°C. The (111) peak intensity in the x-ray pole figure increases gradually as the annealing temperature rises. Consequently, the value of apparent crystal anisotropy constant increases gradually up to 750°C. When the annealing temperature is over 750°C, the apparent crystal anisotropy constant is -8.3×10^5 erg/cm^3. (auth)

3147 LOW-TEMPERATURE ELECTRICAL RESISTIVITY AND HALL EFFECT OF SINGLE-CRYSTAL α-TUNGSTEN CARBIDE. Bachmann, Kurt; Williams, Wendell S. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. J. Appl. Phys.; 42: No. 11, 4406-7(Oct 1971).

The cubic monocarbides of the transition metals are nonstoichiometric compounds with large residual resistivities due to their high vacancy contents. Hence, the Fermi surface studies needed to test several proposed and conflicting band structures are not feasible. A compound with similar physical properties but different crystal structure, α-WC, can be made with fewer vacancies and offers some hope of providing long enough electron mean free paths for oscillatory studies. The first electrical measurements on single crystals of this solid are reported. Indeed, the residual resistivity is far lower than for a cubic carbide, 0.45 $\mu\Omega$ cm, compared with values of 10 or higher. Further improvement appears likely. (auth)

3148 HIGH RESISTIVITY OF dc-SPUTTERED METAL FILMS. Lee, William W. Y. (General Telephone and Electronics Labs., Bayside, N. Y.). J. Appl. Phys.; 42: No. 11, 4366-70(Oct 1971).

Tungsten films were sputtered at 1.5-kV cathode voltage under various sputtering conditions. It was found that their resistivities differ greatly, ranging from 5×10^3 $\mu\Omega$. The higher-resistance case corresponds to films deposited in the diode mode at 50-μ argon pressure, and the lower to films deposited in the triode mode at 2-μ pressure. The higher-resistivity tungsten films have properties similar to the so-called "low-density tantalum" and a host of other metal films which have been prepared under similar sputtering conditions. Analysis by rf spark-source mass spectroscopy and electron microscopy supports the theory that the high resistivity was caused by the incorporation of residual gases during the growth process. (auth)

3149 MAGNETIC PROPERTIES OF $Gd_xTh_{1-x}CuAl$ AND NUCLEAR MAGNETIC RESONANCE IN GdCuAl. Buschow, K. H. J. (Philips Research Labs., Eindhoven, Netherlands); van Diepen, A. M.; de Wijn, H. W. J. Appl. Phys.; 42: No. 11, 4315-18(Oct 1971).

The magnetic properties of the intermetallic compounds $Gd_xTh_{1-x}CuAl$ ($0.2 \leq x \leq 1.0$) are reported for temperatures between 2.1 and 300°K. These compounds become ferromagnetic at low temperatures. Curie temperatures and magnetic moments are derived. The paramagnetic Curie temperature varies quite anomalously with x. The variation is compared with that calculated in terms of the Ruderman–Kittel–Kasuya–Yosida theory. In GdCuAl, the ^{27}Al Knight shift was measured between 190 and 300°K. For the effective exchange constant Γ and the Fermi wave vector k_F, values of +0.5 eV and 1.13 Å^{-1}, respectively, were estimated. (auth)

3150 GALVANOMAGNETIC EFFECT ON FERMI SURFACE AND AC AND DC MEASUREMENTS OF MOLYBDENUM AND MOLYBDENUM–RHENIUM ALLOYS. Liu, Po-ching. Houston, Tex.; Rice Univ. (1971). 121p. University Microfilms Order No. 71-26,315.

Thesis.

By treating the Fermi surface as a rigid unit, the galvanomagnetic coefficients $\sigma_{xx}(J_x)$ and $\sigma_{xy}(R_H, J_y$, or $\rho_{xy})$ were calculated for spherical, cubic, and octahedral Fermi surfaces. The shape factors (S) 1, 2, and $^2/_3$ are associated with the expression $\alpha\tau H_z = (eH/_mR_c)\tau$ in this semiclassical approach of calculating σ_{xx} and $\sigma_{xy}(R_H)$. The Fermi-surface parameters of molybdenum were described and calculated; the Fermi surface of molybdenum is closed and charge carriers are compensated. Using the Hall-coefficient value of polycrystalline molybdenum as a guideline, and with the aid of semiclassical approach, it was estimated that $(Z_e/m_e) \sim 0.3(\tau_h/m_h)$. For the measurements, a sample holder was designed and was successfully operated at low temperature and high magnetic field. With the aid of a PAR HR-8 Lock-in Amplifier an ac circuit was designed, and measurements were made on $^1/_4$ in. diameter thin molybdenum slabs (~10 mil) by Van der Pauw's method at T = 77 and 300°K. A large amount of inductive components were identified, and the corresponding inductance was found to be 0.355 μh in a series of frequency tests. For future operation, a compensator including a phase shifter was designed and incorporated into the measuring system. Dc measurements were made on molybdenum and molybdenum–rhenium alloys at both room and liquid-nitrogen temperatures by a Honeywell 2773 six-digit potentiometer and a Keithley 148 nanovoltmeter. No detectable magnetoresistance was found in both molybdenum and molybdenum–rhenium alloys. This could be due to the random arrangement of component grains in the specimens. The measured resistivities increase linearly from 0%–Re alloy to 25%–Re alloy. Thus, alloying rhenium with molybdenum does not increase the effective number of conduction electrons but enhances the amount of scattering centers and affects both the relaxation time τ and effective mass m* in hole and electronic bands, though the rhenium atom carries one more s-electron than molybdenum. (Diss. Abstr. Int., B)

3151 THERMAL LATTICE EXPANSION OF VARIOUS TYPES OF SOLIDS. Shah, Jayantkumar Shantilal. Rolla, Mo.; Univ. of Missouri (1971). 126p. University Microfilms Order No. 71-25,776.

Thesis.

Thermal lattice expansion studies were carried out and correlated to crystallographic and other properties. The advantages and limitations of various methods of studying thermal expansion are discussed in detail. A new design for a versatile low-temperature camera to study expansion by an x-ray method is proposed. The thermal lattice expansion of silicon was negative below 119°K. This behavior is discussed in terms of crystal structure and interatomic bonding. Diamond exhibits no anomalous thermal expansion. Lattice parameter data for many metals at low temperatures are reported for the first time. The thermal-expansion behavior of Fe, Cu, Ni, W, and Cr is typical for metals. A large difference between the present results and the published data (obtained by measuring bulk expansion) was observed for tungsten. This is explained in terms of the lack of a theoretical density for the bulk samples. Tungsten and chromium show no thermal expansion anomalies despite the theoretical predictions and some indirect evidence. The small magnitude of the thermal expansion of Al_2Au is discussed in terms of the interatomic bonding in the structure. LiF shows constant values of Grueneisen parameters at unusually high temperatures. The thermal expansion behavior of magnetic intermetallic compounds such as R_2M_{17} (R = Y, Lu, Gd and M = Fe, Co, Ni) is clearly correlated to their magnetic properties and crystallographic structures. An anomalous thermal expansion in the c direction is found for R_2F_{17} compounds below their magnetic ordering temperatures. This is explained in terms of the Fe–Fe interatomic distances and number of Fe nearest neighbors in the crystal. No such anomalous behavior is found for the isostructural R_2Co_{17} or R_2Ni_{17} compounds. The ferromagnetic-to-helimagnetic transition in Lu_2Fe_{17} can be understood as due to negative direct interactions and stored magnetic energy in the substitution zone. (Diss. Abstr. Int., B)

3152 EFFECT OF UNIAXIAL STRESS ON MAGNETIC FIELD INDUCED HELIMAGNETIC–FERROMAGNETIC PHASE TRANSITION IN SINGLE-CRYSTAL DYSPROSIUM. Benningfield, L. V. Jr. Houston, Tex.; Rice Univ. (1971). 118p. University Microfilms Order No. 71-26,257.

Thesis.

The effect of applied uniaxial stresses on the value of the critical field, at which the helimagnetic–ferromagnetic phase transition occurs, in single-crystal dysprosium was studied. Measurements were made with stress applied along the hexagonal axis and along the nearest-neighbor direction, at temperatures between 85 and 179°K. The maximum stress employed was 1.5 kbar; this is comparable to the effective internal stress due to magnetostriction naturally occurring in dysprosium. Uniaxial compressive stress along the c-axis inhibits the magnetostrictive-c-axis expansion, leading to a positive shift of the critical field of typically an Oersted per bar. Uniaxial compressive stress in the basal plane and perpendicular to the magnetization direction aids the magnetostrictive contraction, leading to a negative shift of the critical field of approximately the same magnitude. In addition, any stress applied at low temperature inhibits the magnetization process, leading to a broadening of the helimagnetic–ferromagnetic transition. A comparison of the experimental results with theoretical predictions based on the usual phenomenological Hamiltonian yields additional information about the magneto-elastic contributions to this Hamiltonian. (Diss. Abstr. Int., B)

3153 LOW-TEMPERATURE HEAT CAPACITIES OF SOME CHROMIUM–NICKEL AND CHROMIUM–MOLYBDENUM–IRON ALLOYS. Baum, Neal Patrick. Syracuse, N. Y.; Syracuse Univ. (1971). 115p. University Microfilms Order No. 71-23,431.

Thesis.

The molar specific heats of some chromium-based alloy systems were measured in the temperature range of 1.3 to 4.2°K. The particular alloy systems studied were the binary chromium–nickel and the ternary $Cr_{(0.75-x)}Fe_xMo_{0.25}$. The chromium–nickel data is compared to the earlier results of Cheng et al. on chromium-based alloys. In marked contrast to the latter's experimental data on chromium–iron and chromium–manganese, the electronic specific heat coefficient of the chromium–nickel system does not exhibit a radical dependence upon composition. The coefficients of T^3 of some of the binary alloys are relatively high. This observation was attributed to the effect of antiferromagnetic spin waves. The temperature dependence of the specific heat of the ternary alloys is somewhat unusual and is attributed to the observed formation of precipitates in these alloys. (Diss. Abstr. Int., B)

3154 CHANGES IN ELECTRICAL CONDUCTIVITY OF DISCONTINUOUS MOLYBDENUM FILMS UPON EXPOSURE TO OXYGEN. Deshpande, Shivajirao M. Burlington, Vt.; Univ. of Vermont (1971). 123p. University Microfilms Order No. 71-25,450.

Thesis.

Radio-frequency ac methods were used to avoid difficulties of dc measurements on discontinuous films. It was found possible to represent the electrical behavior of thin molybdenum films by a simple equivalent circuit composed of frequency-independent resistors and capacitors. Numerical values of the circuit components, and changes in them due to the presence of oxygen, were determined by studying the frequency-dependent response of the films. These values in turn can be associated with conduction in the metallic grains of the film and with tunneling across the intergranular gaps. In addition to the ac measurements, dc studies were conducted which showed that the films first form a chemisorbed monolayer when exposed to oxygen, followed by the oxidation of the metal islands. Oxidation rates were found which agree fairly well with those of other similarly prepared refractory metal films. (TSS) (Diss. Abstr. Int., B)

3155 INVESTIGATIONS INTO THE MONOTONIC MAGNETOSTRICTION AND MAGNETIC BREAKDOWN IN CADMIUM. Carter, James Milo. Rolla, Mo.; Univ. of Missouri (1970). 101p. University Microfilms Order No. 71-22,383.

Thesis.

Observations of the monotonic magnetostriction of cadmium at 4.2°K and in fields of 65 kG were made. The angular dependence of an extremal point (H_m) in the monotonic magnetostriction is found to follow inverse cosine behavior. The magnitude of H_m (27 kG) for fields parallel to [0001] is in fair agreement with the onset of γ_s from the breakdown of the trifoliate orbit, γ. The range of observation of H_m coincides with the reported range of the trifoliate orbit. A "kink" in the monotonic magnetostriction is demonstrated. The "kink" field, H_k, is constant in value at 23 kG to 60° from the c axis in a $\{10\bar{1}0\}$ plane. (Diss. Abstr. Int., B)

3156 STUDY OF MASS AND CHARGE TRANSPORT IN THORIA. Choudhury, Nabendu Sekhar. Ames, Iowa; Iowa State Univ. (1971). 97p. University Microfilms Order No. 71-26,845.

Thesis.

Ac conductivity and open-circuit emf studies on two batches of undoped thoria were conducted and parabolic weight gain measurements were made for thorium oxidation in pure O_2 gas. The conductivity and emf data were used to delineate the high P_{O_2} and low P_{O_2} ionic domain boundaries. The band-gap energy of thoria was calculated as $(Q_\oplus + Q_\ominus)$, the sum of the activation energies of p-type and n-type electronic conduction. The oxygen permeability of thoria tubes and the oxidation rate constant of thorium were predicted from the conductivity and emf data and then compared with direct measurements. Excellent agreement between the calculated and measured permeability was obtained; however, there was poor correlation between the predicted and measured oxidation kinetics. (TSS) (Diss. Abstr. Int., B)

3157 LOW-TEMPERATURE SPECIFIC HEAT AND RELATED THERMODYNAMIC FUNCTIONS OF NEODYMIUM DIHYDRIDE $NdH_{2.00}$. CRYSTAL FIELD EFFECTS. Bieganski, Z. (Inst. for Low Temperature and Structural Research, Wroclaw). Phys. Status Solidi (b); 47: No. 1, 93-7(1 Sep 1971).

The heat capacity of neodymium dihydride $NdH_{2.00}$ was measured over the low-temperature range by adiabatic calorimetry. At 298.15°K, the measured heat capacity at constant pressure (C_p), the entropy (S^0), the enthalpy function ($H^0 - H_0^0$), and the Gibbs function $[(F^0 - H_0^0)/T]$ are: 10.29 cal mol^{-1} deg^{-1}, 14.08 cal mol^{-1} deg^{-1}, 1882 cal mol^{-1}, and 7.76 cal mol^{-1} deg^{-1}, respectively. The influence of the crystal field of cubic symmetry on the splitting of the ground level ^4I of the Nd^{3+} ion was analyzed, and the conclusion was drawn that the quartet Γ_8^4 is the lowest-lying level. This supports the idea of the anion-like character (hydridic model) of hydrogen in this hydride. (auth)

3158 INTERPRETATION OF MAGNETIC STRUCTURES OF TNi_3 COMPOUNDS BY USE OF A CRYSTAL FIELD. Rossat-Mignod, J.; Yakinthos, J. (CEN, Grenoble, France). Phys. Status Solidi (b); 47: No. 1, 239-45(1 Sep 1971). (In French).

Neutron-diffraction experiments give evidence for an important anisotropy of the rare earth ions (T) in TNi_3 compounds (T = Pr, Nd, Tb, Ho, Er, and Tm). A point-charge crystal-field calculation is used to explain qualitatively the collinear and canted magnetic structures. It is shown that the crystal-field anisotropy is significantly different for the two sites of this complex structure. (auth)

3159 STRUCTURAL EFFECTS AT THE CURIE POINT OF GADOLINIUM. Vorobev, V. V.; Palatnik, M. I.; Finkel, V. A. (Gorky State Univ., USSR). Phys. Status Solidi (b); 47: No. 1, K53-8(1 Sep 1971).

A study was made of the behavior of the thermal expansion coefficient of Gd near the Curie point (~290°K). X-ray diffraction at 77 to 320°K was used. The coefficients $\alpha_\perp$ and $\alpha_\parallel$ were calculated from the temperature dependences of the lattice parameters a and c, respectively. The results show a positive jump in $\alpha_\perp$ and a negative jump in $\alpha_\parallel$ at the Curie point, as predicted. A log $(|T - T_c|)$ dependence and a $(|T - T_c|)^{\frac{1}{2}}$ dependence fit the experimental curve for $\alpha_\parallel$ equally well. The parameters A and B for the equation $\alpha = A \log|T - T_c|/T_c + B$ were determined for the regions above and below the Curie point. (D.L.C.)

3160 PARAMAGNETIC ORBITAL SUSCEPTIBILITIES OF TRANSITION METALS. Place, C. M.; Rhodes, P. (Univ. of Leeds, Eng.). Phys. Status Solidi (b); 47: No. 2, 475-86(1 Oct 1971).

The results of numerical calculations of the paramagnetic contribution, $\chi^d_{orb.}$, to the magnetic susceptibility associated with the orbital motion of electrons in unhybridized tightly bound d-bands are presented. These results are used to determine approximately the dependence of $\chi^d_{orb.}$ on the number of electrons in the band and on the d-band width, and to estimate $\chi^d_{orb.}$ for a number of transition metals. The results obtained are in good agreement with estimates obtained from experimental data. The effect of conduction band–d-band hybridization on $\chi^d_{orb.}$ is also considered. (auth)

3161 OPTICAL PROPERTIES OF BORON CARBIDE AND COMPARISON WITH β-RHOMBOHEDRAL BORON. Werheit, H.; Binnenbruck, H.; Hausen, A. (Univ., Cologne). Phys. Status Solidi (b); 47: No. 1, 153-8(1 Sep 1971).

The optical absorption spectrum of $B_{12}C_3$ exhibits an indirect interband transition with onset at $\hbar\omega = (0.48 \pm 0.03)$ eV. In the subsequent region of lower absorption ($\alpha \approx 400$ cm^{-1}), traps of great density are essentially effective for the optical properties. The lattice vibration spectrum starting at 4 μm has oscillations at 6.55, 9.25, 10.5, 11.9, 14.4, 17.3, and 25.4 μm. A monotonic increase of the reflectivity occurring at wavelengths $\lambda > 30$ μm can be assigned to the strongly damped plasma resonance of free holes. The comparison with the properties of β-rhombohedral boron indicates distinct similarities. (auth)

Moessbauer Effects and NMR

3162 ESR STUDY OF CERIUM(IV) OXIDE IN VACUUM, AIR, AND HYDROGEN. Steinberg, M. (Hebrew Univ., Jerusalem). Israel J. Chem.; 8: No. 6, 877-81(1970).

Cerium(IV) oxide prepared at high temperatures in air shows ESR absorption signals. The oxide prepared at low temperatures shows very diffuse signals. Heating the oxide in vacuum at 1000° or in hydrogen at 298° results in a reduction of the intensity of the signal. A theory was developed to show that the ESR signal is obtained from the quasi-free electron in nonstoichiometric ceria. (auth)

3163 ISOMER SHIFTS OF THE 6.25-keV γ RAYS OF ^{181}Ta. Salomon, D.; Kaindl, G.; Shirley, D. A. (Univ. of California, Berkeley). Phys. Lett.; 36A: No. 6, 457-8(11 Oct 1971).

Large isomer shifts in the Moessbauer absorption line of the 6.25-keV γ rays of ^{181}Ta were observed with sources of ^{181}W diffused into single crystals of Mo, Nb, Ir, Pt, W, and Ta and absorbers of Ta metal and $KTaO_3$. (auth)

3164 MOESSBAUER EFFECT OF ^{57}Fe IN THORIUM OXIDE. Erickson, Gerald Arthur. Seattle, Wash.; Univ. of Washington (1971). 110p. University Microfilms Order No. 71-24,033.

Thesis.

The Moessbauer Effect (ME) of ^{57}Fe in ThO_2 materials was studied at several temperatures between 10 and 300°K. The Moessbauer fraction f, isomer shift I.S., linewidth Γ, and quadrupole splitting ΔE_Q were determined for each temperature. Low-temperature anharmonicity was evidenced by the temperature dependence of f. A simple squared-winebottle potential with radial parameters R_1 and R_2 was used to fit the f and I.S. data. The resultant value for R was in reasonable agreement with the rattle space predicted by the ionic hard-spheres model. The source emission line shapes were fitted best by a calculation employing relaxation between two electronic orbital states. (Diss. Abstr. Int., B)

3165 NUCLEAR MAGNETIC RESONANCE IN DILUTE TIN-BASED ALLOYS. Daugherty, Michael James. Riverside, Calif.; Univ. of California (1971). 169. University Microfilms Order No. 71-27,074.

Thesis.

The magnetic resonance of the ^{119}Sn nucleus was observed in the tin-based alloys Sn–In and Sn–Sb at 4.2°K. The observed resonance line shapes cannot be explained without invoking the eddy-current mixing of the nuclear absorption and dispersion described by Chapman, Rhodes and Seymour. A technique for analyzing the inhomogeneously broadened tin line shape is developed that takes this effect into account explicitly. This analysis is used to determine the concentration and field dependence of the isotropic and anisotropic Knight shifts, the unmixed single crystal linewidth, and the eddy-current mixing ratio for both alloy series. The isotropic Knight shift is found to be approximately independent of solute concentration to 2.0 at.% solute with $|(1/K)(dK/dc)|$ less than (2.5×10^{-3})/at. %. The anisotropic Knight shift is linear in solute concentration with $\{(1/KA)(dKA/dc)\}$ being $+(5.6 \pm 2.8) \times 10^{-2}$/ at. % and $-(9.9 \pm 0.7) \times 10^{-2}$/ at. % in the Sn–In and Sn–Sb alloys, respectively. The concentration and field dependence of the line width are in qualitative agreement with the scattering theory, and the concentration and field dependence of the eddy-current-mixing ratio are in good agreement with the theory of Chapman et al. The anomalous concentration dependence of the Knight shift in the dilute indium-rich alloys reported by Anderson, Thatcher, and Hewitt is shown to be the result of the concentration dependence of the eddy-current-mixing ratio in these alloys. Other experimental results are re-examined in the light of the above results. (Diss. Abstr. Int., B)

3166 NUCLEAR ORIENTATION OF ^{142}Pr IN PRASEODYMIUM METAL. Smith, Carl Hofland. Minneapolis; Univ. of Minnesota (1971). 80p. University Microfilms Order No. 71-22,244.

Thesis.

The anisotropy of gamma radiation emitted by ^{142}Pr nuclei in polycrystalline praseodymium was measured in applied fields up to 41.7 kOe and temperatures down to probably 0.012°K. The observed anisotropies were fitted to a model in which an appropriate powder average was taken of the electronic moments measured by Lebech and Rainford by neutron diffraction from a single crystal of praseodymium in applied fields. The Van Vleck moments calculated from the crystal field eigenfunctions and energy splittings of Bleaney do not provide a large-enough internal field to cause the observed anisotropies. In order to explain the large orientation observed, the first-forbidden beta decay of ^{142}Pr must be assumed to be almost pure Fermi with zero units of angular momentum usually carried away by the beta–neutrino pair. (Diss. Abstr. Int., B)

3167 NMR AND NUCLEAR RELAXATION STUDY OF SATELLITE LINES IN DILUTE Co–Cr, Co–V, AND Co–Mn ALLOYS. Aslam, Javed. Minneapolis; Univ. of Minnesota (1971). 85p. University Microfilms Order No. 71-22,181.

Thesis.

Distribution of hyperfine fields at cobalt nuclei in the dilute alloys of Co–Cr, Co–V, and Co–Mn using NMR techniques at 4.2°K was studied. The spectra for Co–Cr and Co–V alloys are characterized by three satellite lines in addition to the main cobalt line. For Co–Mn alloy, only one clearly resolved satellite line has been observed at 209.5 MHz. The absence of any splitting in this line gives an upper limit to the pseudodipolar moment of $-(1.9 \pm 0.7)\mu_B$. A phenomenological model similar to that of Streever and Uriano and Kobayashi et al. was used to predict the hyperfine field shifts corresponding to the Zeeman frequency of the various neighboring satellite lines using the magnetic moment distribution on cobalt atoms around these impurities in the light of recent neutron diffraction work of Cable and Hicks. The agreement between the observed and predicted hyperfine field shifts is quite good for Co–Cr and Co–V alloys, but there is a large discrepancy in the case of Co–Mn alloy if the satellite line is assumed to be the nearest neighbor line. The nuclear spin–spin relaxation time T_2 was measured for cobalt nuclei at the main line and all satellite lines in the alloys. At the main line, T_2 is shorter than that in pure cobalt (30 to 50 μsec in the alloys, 88 μsec in pure cobalt). However, at all the satellite lines T_2 is greater than that in pure cobalt. The data are discussed in qualitative terms on the basis of the Suhl–Nakamura interaction and a pinning of domain walls caused by the presence of impurities as suggested by Stearns. Finally, an echo envelope modulation was observed for the satellite line at 172.5 MHz in the Co–Cr alloy. The modulation period is $(5.5 \pm 0.5)\mu$sec and is shown to be of quadrupolar origin resulting from the broken symmetry of the lattice due to alloying. (TSS) (Diss. Abstr. Int., B)

3168 SPIN–LATTICE RELAXATION IN THE METAL–HYDROGEN SYSTEMS ON THE BASIS OF TRANSITION METALS OF THE IVb SUBGROUP. Khodosov, E. F.; Shepilov, N. A. (Physical-Technical Inst., Donetsk, USSR). Phys. Status Solidi (b); 47: No. 2, 693-702(1 Oct 1971).

The spin–lattice relaxation times in the systems Ti–H, Zr–H, and Hf–H were measured by the spin-echo method as functions of temperature and hydrogen concentration. The theoretical values of $T_{1min.}$ were calculated in the temperature range where $\omega\tau_c = 1.4$.

Comparison of the theoretical and experimental values $T_{1min.}$ allowed one to appreciate the translational diffusion contribution and the possible electronic contribution in the spin–lattice relaxation. The parameters of the hydrogen self-diffusion were found. The results are in satisfactory agreement with theoretical concepts developed by Bloembergen et al. and Torrey. (auth)

3169 CRYSTALLINE FIELD AND MOESSBAUER EFFECT IN $DyNi_3$. Yakinthos, J.; Rossat-Mignod, J.; Belakhovsky, M. (CEN, Grenoble). Phys. Status Solidi (b); 47: No. 1, 247-50 (1 Sep 1971). (In French).

The validity of a point-charge-model calculation in the intermetallic $DyNi_3$ compound was tested by comparison with Moessbauer results on ^{161}Dy. The magnetic structure obtained by neutron diffraction was thus interpreted. (auth)

3170 ELECTRON PARAMAGNETIC RESONANCE OF THE Cr^{3+} ION IN MONOCLINIC ZrO_2. Bacquet, G.; Dugas, J.; Escribe, C. (CNRS, Toulouse). Phys. Status Solidi (b); 47: No. 1, 177-84(1 Sep 1971). (In French).

ESR spectra of Cr^{3+}-doped monoclinic zirconium dioxide show the resonance of two distinguishable centers. The spectra can be explained using a second-order Hamiltonian, the constants of which are the same for both defects. Only the orientation of the crystal-field tensor axes is different. (auth)

3171 MOESSBAUER EFFECT IN NEPTUNIUM COMPOUNDS. Aleksandrov, B. M.; Kalyamin, A. V.; Krivokhatskii, A. S.; (and others). Sov. Radiochem. (Engl. Transl.); 12: No. 6, 822-5 (Nov-Dec 1970).

Translated from Radiokhimiya; 12: No. 6, 852-7(Nov-Dec 1970).

The isotope ^{237}Np has a Mössbauer level with energy 59.6 keV and a lifetime of 6.3×10^{-9} sec. The most convenient source of Mössbauer radiation is ^{241}Am, the α-decay of which leads to the formation of this isomeric state of ^{237}Np. Mössbauer spectra containing various contents of americium give information on the forms of stabilization of neptunium in a time of $\sim 10^{-7}$ sec after the α-decay of americium. It is noteworthy that the chemical shifts on the lines reach several centimeters per second. The increased sensitivity of the shifts to the electronic surroundings can serve as an effective means for investigating the state of neptunium in crystalline substances. An investigation of the Mössbauer effect on neptunium using various sources and absorbers is reported here. (auth)

Theoretical Physics

Refer also to abstracts 2216, 2223, 2268, 2273, 2274, 2335, 2742, 3396, 3407, and 3430.

3172 CONSIDERATION OF ABSORPTION IN MEDIUM IN THEORY OF GENERATION OF X TRANSITION RADIATION. Garibyan, G. M. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Fiz.; 6: No. 1, 3-6(1971). (In Russian).

The consistent regard for an absorption capacity of matter is given in the framework of the conventional theory of transition radiation generated in a laminated medium. (auth)

3173 RADIATION OF FAST CHARGED PARTICLES IN MAGNETIC AND ELECTRIC UNDULATORS. Korkhmazyan, N. A.; Elbakyan, S. S. Izv. Akad. Nauk Arm. SSR, Fiz.; 6: No. 1, 7-11(1971). (In Russian).

The problem of radiation emission of relativistic charged particles during motion in stepwise homogeneous static electric and magnetic fields is considered. (auth)

3174 INFLUENCE OF RADIATION DIFFUSION ON THE LINE PROFILE OF RESONANCE LINES. Falk, H. (Zentralinstitut fuer Optik und Spektroskopie, Berlin); Becker-Ross, H.; Schiller, H. Ann. Phys. (Leipzig); 26: No. 2, 166-77(1971). (In German).

The theory of self-reversal of resonance lines is extended to decay of high particle densities. The Monte Carlo method was employed for computation of line profiles. Results showed that, in contradiction of the theory of Cowan and Diecke, uniformly excited radiation sources could also show self-reversal. (tr-auth)

3175 EXPLICIT FORMULAS IN DEGENERATE RAYLEIGH–SCHROEDINGER PERTURBATION THEORY FOR THE ENERGY AND WAVE FUNCTION, BASED ON A FORMULA OF LAGRANGE. Silverstone, Harris J.; Holloway, Thomas T. (Johns Hopkins Univ., Baltimore). Phys. Rev., A; 4: No. 6, 2191-9(Dec 1971).

The solution for the energy and wave function in degenerate Rayleigh–Schroedinger perturbation theory is obtained via a formula of Lagrange. The derivation involves manipulation of the Brillouin–Wigner formulas in a manner similar to the "repeated-partitioning" technique. (auth)

3176 THEORY OF MANY-BOSON SYSTEMS IN THE WEAK-COUPLING LIMIT. Lee, D. K. (Univ. of Kansas, Lawrence). Phys. Lett.; 37A: No. 1, 49-50(25 Oct 1971).

Generality of the uniform-limit formalism is demonstrated for several typical many-boson model systems in the weak-coupling limit. (auth)

3177 CLASSICAL SCATTERING OF RADIATION BY AN OSCILLATING ELECTRON. Zakowicz, W. (Inst. of Nuclear Research, Warsaw). Phys. Lett.; 37A: No. 2, 105-6(8 Nov 1971).

It is shown that classically described scattering of light by an oscillating electron leads to a spectrum consisting of many stokes and antistokes lines. For this scattering formulas for n-th order correlation functions are given. It appears that this process can be interpreted as phase modulation of radiation. (auth)

3178 CHIMERAS. Bisshopp, Frederic (Brown Univ., Providence). Ann. Phys. (N. Y.); 65: No. 1-2, 418-37(15 Jun 1971).

The propagation of nonlinear wave packets and modulated beams, and other features of nonlinear wave propagation can be described in terms of several approximate, heuristic theories. The neoclassical approximation presented is representative of a style of approximation that includes a number of the approximations currently in use as special cases or as limiting cases. It is, in a manner of speaking, the best approximation of its kind in the sense that it coincides with the nonlinear wave equation from which it is derived in more limiting cases than any of the others, and though it too is heuristic, it is rational, being the first of a sequence of approximations that converges to a solution if it converges. Chimeras are the solutions of the equations of the neoclassical approximation; there are a number of exact ones exhibited that describe phase shocks, self-focused beams, and localized wave packets that travel, without change of shape, at an arbitrary uniform velocity less than one. (auth)

3179 PROPOSED EXPERIMENT TO TEST LOCAL HIDDEN-VARIABLE THEORIES. Fox, R.; Rosner, B. (Technion-Israel Inst. of Tech., Haifa). Phys. Rev., D; 4: No. 4, 1243-4(15 Aug 1971).

It is shown that by making a plausible assumption concerning the behavior of linear polarizers, it is possible to relax the experimental condition of Clauser, Horne, Shimony, and Holt for testing local hidden-variable theories. (auth)

3180 EXPECTATION VALUES OF MANY-FERMION SPIN EIGENSTATES. Ruedenberg, Klaus (Ames Lab., Iowa). Phys. Rev. Lett.; 27: No. 17, 1105-8(25 Oct 1971).

Many-particle antisymmetric spin eigenstates are formulated in a manner that leads to simple expressions for expectation values of spin-independent many-particle operators. Explicit matrix elements are given for one- and two-particle operators. (auth)

3181 ADIABATIC THEOREM FOR NONCONSERVATIVE SYSTEMS AND ITS CONSEQUENCES IN INTERACTIONS BETWEEN MATTER AND RADIATION. Lochak, Georges (Institut de France, Paris). Compt. Rend., Ser. B; 272: No. 23, 1281-4 (7 Jun 1971). (In French).

It is shown that in wave mechanics a system perturbed by a periodic field possesses invariant adiabatic bound states which are associated with the eigenvalues of a first integral (reduced energy), and which link up, for a zero field, with the stationary states of a nonperturbed system. It is concluded that the sharp-edged wave functions and the transient processes at the entry and exit of the field must play a dominant role in the production of quantum transitions. (France)

3182 UPON ELECTRIC CHARGE SYSTEMS MOVING WITHOUT ACCELERATION AND ASSOCIATED WITH CHARGE CREATION. Chambers, Ll. G. (University Coll. of North Wales, Bangor). Int. J. Theor. Phys.; 4: No. 5, 321-5(Sep 1971).

A discussion is given of certain electromagnetic fields associated with charges moving with zero acceleration. These fields involve zero magnetic field and the creation of charge. (auth)

3183 SOLUTION OF THE DIRAC EQUATION IN A MAGNETIC FIELD. Sen Gupta, N. D. (Tata Inst. of Fundamental Research, Bombay). Indian J. Pure Appl. Phys.; 6: No. 9, 459-60(Sep 1968).

It is shown that, in a steady magnetic field, the Dirac equation can be reduced to the problem of simultaneous linear homogeneous partial differential equations of two unknown scalar functions. The solutions are further simplified for application in two special cases: when the magnetic field is (i) symmetric about an axis, and (ii) invariant with respect to translation along a direction. The problem in these cases reduces to the solution of a second-order partial differential equation. (auth)

3184 EXPLICIT DECOMPOSITION OF A GENERAL TWO-BODY HAMILTONIAN INTO IRREDUCIBLE SYMPLECTIC TENSORS. Li, Shou-yung (Univ. of Rochester, N. Y.). J. Math. Phys. (N. Y.); 12: No. 10, 2221-6(Oct 1971).

The seniority classification of a general two-body Hamiltonian according to the group chain $U(N) \supset Sp(N) \supset R(3)$ is considered. It is found that, by using the standard contraction and symmetrization process, one can explicitly decompose such a Hamiltonian into irreducible tensors with respect to the symplectic group. An example is given in which the explicit angular-momentum-coupled form of these tensors is also worked out. (auth)

3185 RADIATION FROM CHARGED PARTICLE EXECUTING HELICAL MOTION IN A MAGNETO-IONIC MEDIUM. King, Harry Stephen. Columbus, Ohio; Ohio State Univ. (1971). 200p. University Microfilms Order No. 71-27,498.

Thesis.

The emissivity and the far-field asymptotic electric field are derived for an electron moving in a helical path about a static magnetic field in an anisotropic magneto-ionic medium. Both the Hamiltonian and the Fourier transform method are used to obtain these expressions. The results using each method are compared and are found to yield equivalent results. A review of the literature and the historical development of classical electrodynamics in anisotropic media is presented. Also, a number of errors present in the literature are discussed. The volume emissivity from a distribution of gyrating electrons in a magneto-ionic medium is derived. A computer program is developed for use on The Ohio State University's IBM 360 computer. Curves of the volume emissivity, calculated by the computer program, are presented for a monoenergetic distribution of electrons with an isotropic pitch angle distribution. (Diss. Abstr. Int., B)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

3186 CHARACTERISTICS OF NUCLEAR INTERACTIONS WITH LARGE ENERGY TRANSFER TO π^0 MESONS. Babayan, Kh. P. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Fiz.; 6: No. 2, 96-105(1971). (In Russian).

The results of analysis of nuclear interactions with large energy transfer to π^0-mesons are given. Also certain characteristics of cosmic particle specific interactions are presented for particle energies ≥1000 GeV. (auth)

Electromagnetic

Refer also to abstracts 3133 and 3238.

3187 (DESY-71/44) COINCIDENCE EXPERIMENT ON INELASTIC ELECTRON-PROTON SCATTERING IN THE REGION OF THE Δ(1236) AT $q^2 = -0.35$ AND -1.0 $(GeV/c)^2$. Galster, S.; Hartwig, G.; Klein, H.; Moritz, J.; Schmidt, K. H.; Schmidt-Parzefall, W.; Wegener, D.; Bleckwenn, J. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Aug 1971. 23p. Dep. NTIS (U. S. Sales Only).

Measurements are presented on inelastic electron-proton scattering in the region of the Δ(1236) resonance for two values of q^2. A fit to the single arm and the π^0-electroproduction cross sections gave a separation of the resonance and the nonresonant background contribution. The transition form factor $G_M^*(q^2)$ was determined and shown to have a different dependence on q^2 than the magnetic nucleon form factor, confirming earlier measurements. A fit to the angular dependence of the π^0-electroproduction cross section gives some indications that smaller multipole amplitudes contribute to the resonance besides the dominating M_{1+} amplitude. (auth)

3188 (DESY-71/47) INVESTIGATION OF THE REACTION $e + p \rightarrow e + p + \gamma$ BELOW PION THRESHOLD. Bartel, W.; Buesser, F.-W.; Dix, W.-R.; Felst, R.; Harms, D.; Krehbiel, H.; Kuhlmann, P. E.; McElroy, J.; Meyer, J.; Weber, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sep 1971. 10p. Dep. NTIS (U. S. Sales Only).

The reaction $e + p \rightarrow e + p + \gamma$ was studied between the elastic peak and pion threshold. The data provide an experimental test of higher-order radiative corrections. (auth)

3189 (SLAC-Trans-135) e^+e^- STORAGE-RING EXPERIMENTS. Schildknecht, D.; Willutzki, H. J.; Wolf, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Translated for Stanford Linear Accelerator Center, Calif., from report DESY-71/28. 71p. Dep. NTIS.

This summary of e^+e^- storage-ring experiments covers theoretical aspects and estimates of effective cross sections and counting rates. The verification of quantum electrodynamics, hadron production through one-photon and electron exchange, and weak-interaction experiments are discussed. (J.F.P.)

3190 YOUNG AIR SHOWER STUDY BY A CONTROLLABLE PHOTOEMULSION TECHNIQUE. Babayan, Kh. P. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Fiz.; 6: No. 2, 93-5(1971). (In Russian).

The results of the young air showers study are given for the energy of $e-\gamma$ component equal to $1.4(10)^{12}$ eV. There were 32 events detected by the setup (an ionization calorimeter in conjunction with photographic emulsions). An average value of γ-quanta number in individual interaction acts is about 3.8 ± 0.5. (auth)

3191 COHERENT BREMSSTRAHLUNG INVESTIGATION FROM DIAMOND CRYSTAL. Avakyan, R. O.; Armaganyan, A. A.; Arutyunyan, L. G. (and others) (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Fiz.; 6: No. 2, 138-41(1971). (In Russian).

Monochromatic and polarized beams from a diamond crystal were measured at an electron energy of 4.5 GeV. (auth)

3192 PHOTOPRODUCTION OF POSITIVE IONS AT 180° FROM 0.22 TO 3.1 GeV. Bouquet, B. (Faculte des Sciences, Orsay, France); D'Almagne, B.; Eschstruth, P. T.; (and others). Phys. Rev. Lett.; 27: No. 18, 1244-7(1 Nov 1971).

The π^+ photoproduction cross section in hydrogen was measured at 180° for photon energies from 0.22 to 3.1 GeV by detecting the pion in the backward direction. The statistical accuracy of the measurements varies typically from 3 to 10% depending on the energy. The data are compared with other recent experimental results and predictions of phenomenological theories. (auth)

3193 PRELIMINARY RESULTS CONCERNING THE REACTION $e^+e^- \rightarrow p\bar{p}$ AT A TOTAL ENERGY OF 2.1 GeV. Di Giugno, G. (Instituto Nazionale di Fisica Nucleare, Naples. Univ., Naples); Humphrey, J. W.; Sassi, E.; (and others). Lett. Nuovo Cim.; 2: No. 17, 873-80(23 Oct 1971).

An experimental study of the reaction $e^+e^- \rightarrow p\bar{p}$ at 2.1 GeV using four scintillation counter telescopes and a cylindrical wide-gap spark chamber is described. Preliminary results yield an upper limit to the cross section of $\sigma \leq 0.84$ (10^{-33}) cm^2. (L.B.S.)

Weak

3194 (IFVE-SPK-70-106) INVESTIGATION OF HIGH-ENERGY MUON INTERACTION WITH NUCLEONS AND NUCLEI. Ermolov, P. F.; Sulyaev, R. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 21p. (In Russian). Dep. NTIS (U. S. Sales Only).

A proposal is presented on a survey experiment that is planned to be performed in a 30-GeV negative muon beam using a 2-m propane bubble chamber. A possible way of performing the experiment is given. Besides main processes that are to be registered and the estimation of their yields are given. (auth)

3195 (ITEF-856) REGENERATION AMPLITUDE OF K_1-MESONS ON COPPER AT MOMENTA FROM 0.8 TO 3.8 GeV/c. Balats, M. Ya.; Berezin, V. M.; Vishnevskii, M. E.; Galanina, N. D.; Markizov, V. N.; Memelov, V. V.; Murysov, V. A.; Pavlovskii, F. A.; Semenov, Yu. A.; Chistilin, V. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1971. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

Using a magnetic spectrometer with optical spark chambers the regeneration amplitude for K_S mesons on copper at 0.8 to 3.8 GeV/c was measured. (auth)

3196 MEASUREMENT OF MUON ENERGY IN $\pi^+ \rightarrow \mu^+ + \nu_\mu$ DECAY, UPPER LIMIT FOR THE MUON NEUTRINO MASS. Shrum, E. V.; Ziock, K. O. H. (Univ. of Virginia, Charlottesville). Phys. Lett.; 37B: No. 1, 114-16(1 Nov 1971).

The energy of the muon in the decay $\pi^+ \rightarrow \mu^+ + \nu_\mu$ using a Ge(Li) detector was measured. From the result, $E_\mu = 4.1207 \pm 0.0036$, an upper limit of 1.15 MeV was deduced for the mass of the muon neutrino with a 90% confidence level. (auth)

Strong (Baryon-Induced)

Refer also to abstract 2292.

3197 (FRNC-TH-109) STUDY OF THE $K\bar{K}\pi\pi$ FINAL STATES PRODUCED IN ANTIPROTON ANNIHILATIONS AT REST. THE C MESON PROPERTIES. Marechal, Bernard (Paris Univ. (France). Faculte des Sciences). 1969. 138p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

$K\bar{K}$, $K\pi$, $\pi\pi$ and especially $K\pi\pi$ interactions were studied in the six channels of $p\bar{p} \rightarrow K\bar{K}\pi\pi$ annihilations. All these reactions are characterized by four particles in the final state, two of these four particles being strange particles. They represent about 80% of the $p\bar{p}$ annihilations at rest with strange particles in the final state. The presence of a resonance, named C meson, in the $K\pi\pi$ system near 1230 MeV was demonstrated. The charged component of this meson was observed and its properties were systematically studied (mass, width, spin, parity, isospin, decay modes) using a phenomenological model of final state interactions. (France)

3198 (INP-762, pp 50-182) COHERENT PRODUCTION OF PARTICLES IN HADRON-NUCLEUS SCATTERING (EXPERIMENTAL). Bingham, H. H. (California Univ., Berkeley). Jun 1971. In Proceedings of XI Cracow School of Theoretical Physics. Vol. I.

Some of the gross features expected for coherent production reactions on the basis of simple kinematical relations, nucleon form factor effects, and rotational invariance are reviewed. The kinematics, characteristics of coherent reactions, selection rules for coherent production reactions, the techniques, dominant vacuum exchange reactions, and ω^0 exchange processes are considered. Some of the available data from these reactions are presented. (J.F.P.)

3199 (JINR-E1-6064) PROBABILITY OF FORMATION OF Σ HYPERONIC ATOMS IN VARIOUS ELEMENTS. Zieminska, D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 22p. Dep. NTIS (U.S. Sales Only).

The probability, that a Σ^- hyperon emitted from a K^- meson capture on a nucleus is brought to rest in a given target to form a Σ hyperonic atom, was calculated for carbon, aluminum, iron, silver, gold and uranium. The transmission coefficient of Σ^- hyperon through the parent nucleus was obtained in the WKB approximation with a suitable Σ^- nucleus optical potential. It was found that the probability of formation of a heavy Σ hyperonic atom is about one half that of a light one. (auth)

3200 (JINR-P1-6044) REAL PART OF THE ELASTIC pd-SCATTERING AMPLITUDE AT 70 GeV. Zayachki, V. I.; Khristov, L. G.; Zlatanov, Z. M.; Devenski, P. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 10p. Dep. NTIS (U. S. Sales Only).

By the detection of the nuclear emulsion recoil particles the differential cross sections are measured for the elastic pd-scattering at 70 GeV in the region of small transferred momenta $0.0024 \leq |t| \leq 0.1730$ $(GeV/c)^2$ where the interference of nuclear and the Coulomb forces was observed. The real part of the elastic pd-scattering amplitude was determined to be $a_{pd} = -0.126 \pm 0.063$. (auth)

3201 DOES PROTON-ANTIPROTON ANNIHILATION AT REST CONTAIN HIGH ANGULAR MOMENTA? Benvenuti, A.; Cline, D.; Reeder, D. D.; Rutz, R.; Scherer, V. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881-303. Lett. Nuovo Cim.; 2: No. 17, 881-6(23 Oct 1971).

It is shown that the low rate for the reaction $\bar{p}p \rightarrow K_S^0K_S^0$ relative to the reaction $\bar{p}p \rightarrow K_S^0K_L^0$ does not provide experimental evidence for S-wave $\bar{p}p$ capture. It is also suggested that the available evidence suggests that higher-angular-momentum states may be present in the annihilation at rest. (L.B.S.)

Strong (Meson-Induced)

Refer also to abstracts 2301 and 3330.

3202 (CERN-Trans-71-26) OBSERVATION OF THE REACTION $\pi^-p \rightarrow e^+e^-n$ AT 275 MeV. Akimov, Yu. K.; Vertogradov, A. V.; Dem'yanov, A. V.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Translated by R. Luther (CERN, Geneva, Switzerland), from report JINR-P1-5398. 21p. Dep. NTIS (U. S. Sales Only).

The differential cross sections were measured for backward pion electroproduction in the intermediate momentum range. It was found that this low-intensity reaction can be isolated reliably and that the accuracy of the cross section measurements can be increased considerably. (J.F.P.)

3203 (DESY-71/54) STUDY OF THE CHARGED THREE-PION SYSTEM IN THE MASS REGION OF 1400 TO 1900 MeV, AND THE J^P QUANTUM NUMBERS OF THE $A_3(1640)$. Bassler, E.; Cantore, A.; Caso, C.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sep 1971. 21p. Dep. NTIS (U. S. Sales Only).

From an experiment on the reaction $\pi^+p \rightarrow \pi^+\pi^+\pi^-p$ at 11.7 GeV/c incident momentum a spin and parity analysis of the charged 3π system in the mass range of 1400-1900 MeV is presented. A broad (Γ = 200-400 MeV) enhancement is found in the $J^P = 2^-$, fπ(S wave) state, centered at about 1650 MeV, and no structure in the other fπ partial waves. Thus the J^P quantum numbers of $A_3 \rightarrow f\pi$ are determined to be $J^P = 2^-$. (auth)

3204 (FRNC-TH-59) PRODUCTION OF BARYONS WITH A STRANGENESS OF -2 IN K^-p INTERACTIONS AT 3.9 GeV/c. A PROPOSED NEW METHOD OF ANALYZING THE AMPLITUDES OF THE REACTION. Barrelet, Etienne (Paris Univ. (France). Faculte des Sciences). 1970. 204p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The production of Ξ*(baryons of strangeness −2) was studied in K^-p reactions at 4 GeV/c. There were 250,000 photographs used in the analysis. The Ξ* in states corresponding to more than three bodies were sought (K Ξ* and K* Ξ* channels). The results confirm the existence of Ξ* (2030) and indicate the possible existence of Ξ*(1630), the existence of the latter being confirmed by similar experiments. The results suggest an Ξ* mass spectra between 1700 and 2000 MeV, which is more complicated than that generally accepted. The study of two body reactions $K^-p \rightarrow \Xi K$ beyond the semiquantitative observation of hyperon exchange mechanisms allowed the utilization of a new phenomenological method of analyzing the transition amplitudes. The method is satisfactory for the cases considered and its use may be extended to other cases. Furthermore, it allows the linking up of low energy behavior, for which it generalizes the phase shift analysis, with high energy behavior, for which it parametrizes the structures adjacent to the diffraction peaks. (France)

3205 (INP-762, pp 221-45) COHERENT PROCESSES AT VERY HIGH ENERGIES. Miesowicz, M. (Institute of Nuclear Techniques, Krakow (Poland). Institute of Nuclear Physics, Krakow (Poland)). Jun 1971.

In Proceedings of XI Cracow School of Theoretical Physics, Vol. I.

The production of 3π and 5π systems by pions in nuclear emulsions at very high energies is discussed particularly the energy dependence of the cross section for coherent processes. Also included is the emission of bremsstrahlung photons by electrons at very high energies in dense material, and the effect of multiple Coulomb scattering on this process. The results given were previously known. (J.F.P.)

3206 (TID-25852) HIGH ENERGY PHYSICS. Progress Report. (Tufts Univ., Medford, Mass.). Sep 1971. Contract AT-(11-1)-3023. 22p. (CH-3023-1). Dep. NTIS.

The summary of research presented covers strong interactions and photoproduction. A list of publications is included. (J.F.P.)

3207 MEASUREMENTS OF POLARIZATION IN π^-p ELASTIC SCATTERING AT LARGE ANGLES. Hill, D. (Argonne National Lab., Ill.); Koehler, P. F. M.; Novey, T. B.; (and others). Phys. Rev. Lett.; 27: No. 18, 1241-3(1 Nov 1971).

Measurements were made of polarization in π^-p elastic scattering, with emphasis over the backward region, at 1.60 to 2.28 GeV/c. The results indicate the absence of u-channel dominance in the backward region, as was observed in the case of π^+p scattering. Comparisons were made with predictions of various phase-shift analyses which show that the agreement is generally very poor in the backward region. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 3391, 3636, and 3654.

3208 (CNRS-CPT-71-P-381) APPROACH TO EQUILIBRIUM OF FREE QUANTUM SYSTEMS. Lanford III, O. E.; Robinson, Derek W. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). Jun 1971. 25p. Dep. NTIS (U. S. Sales Only).

It is proved for Fermi systems that each translationally invariant state ω with square integrable correlation functions approaches a limit under the free time evolution. The limit state is the gauge invariant quasi-free state with the same two-point function as ω, and it is characterized by a maximum entropy principle. Various properties of the limit are discussed, and the extension of the results to Bose systems is also given. (France)

3209 (IFVE-SEF-70-82) ON REDUCING n-MULTIPLE CONSECUTIVE INTEGRALS WITH VARIABLE LIMITS TO INTEGRAL OVER n-DIMENSIONAL CUBE IN CALCULATING CROSS SECTIONS FOR MULTIPARTICLE PRODUCTION REACTIONS APPLYING INVARIANT VARIABLES. Folomeshkin, V. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 9p. (In Russian). Dep. NTIS (U. S. Sales Only).

A simple transformation of the variables that allows one to reduce consecutive multiple integral to the n integral over n dimensional cube is presented. The method is illustrated by calculations on cross sections for multiparticle production reactions with application of invariant variables of integration. (auth)

3210 (INP-762) PROCEEDINGS OF THE XI CRACOW SCHOOL OF THEORETICAL PHYSICS. VOLUME I. COHERENT PROCESSES AT HIGH ENERGIES. (Institute of Nuclear Physics, Krakow (Poland)). Jun 1971. 312p. Dep. NTIS (U. S. Sales Only).

Separate abstracts were prepared for the seven lectures presented. (J.F.P.)

For abstracts of individual lectures see: 3198, 3205, 3211, 3237, 3238, 3354, and 3369.

3211 (INP-762, pp 203-20) RELATIVISTIC EIKONAL APPROXIMATION FOR INELASTIC PROCESSES. Harrington, David R. (Rutgers-The State Univ., New Brunswick, N. J. Dept. of Physics). Jun 1971.

In Proceedings of XI Cracow School of Theoretical Physics. Vol. I.

It is shown that in the high-energy or large-mass limit the sum of all arbitrarily crossed inelastic ladder diagrams is equivalent to coupled-channel potential theory if the linearization of the q-line denominators is a good approximation. This suggests that in certain cases the coupled-channel potential theory provides a useful description of inelastic quasi-two-body processes when appropriate kinematic variables are used. The coupled-channel potential-theory eikonal approximation derivation of the absorptive model shows that the usual geometric mean prescription is inadequate unless the initial and final state interactions are very similar or the exchange interaction is of very short range. (J.F.P.)

3212 (INP-763) PROCEEDINGS OF THE XI CRACOW SCHOOL OF THEORETICAL PHYSICS. VOLUME II. (Institute of Nuclear Physics, Krakow (Poland)). 1971. 125p. Dep. NTIS (U. S. Sales Only).

Separate abstracts were prepared for the six lectures presented. (J.F.P.)

For abstracts of individual lectures see: 3213, 3282, 3283, 3304, 3330, and 3431.

3213 (INP-763, pp 3-22) EIKONAL EXPANSION IN THE FADDEEV THREE-BODY APPROACH. Karlsson, B. (Chalmers Tekniska Hogskola, Goteborg (Sweden). Institutionen for Teoretisk Fysik); Namyslowski, J. (Warsaw Univ. (Poland). Inst. for Theoretical Physics). 1971.

In Proceedings of the XI Cracow School of Theoretical Physics. Volume II.

The high-energy scattering of a particle β on a compound system (γ,α) of particles γ and α (for example the scattering of π or N on a deuteron) is considered. The elastic scattering is treated in detail. Nonrelativistic quantum mechanics is used. A systematic study of the eikonal expansion for scattering on a two-body system using the Faddeev equations as the basis of the three-body theory is given. (J.F.P.)

3214 (JINR-E2-6069) EIKONAL REPRESENTATION OF THE SCATTERING AMPLITUDE CONTAINING THE VENEZIANO VIRTUAL BLOCKS. Barbashov, B. M.; Nesterenko, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 9p. Dep. NTIS (U. S. Sales Only).

A Regge eikonal representation is found by means of the functional integration method for a sum of diagrams of the ladder type describing the high-energy scattering of scalar particles. The main point in the model is the exchange of the virtual blocks which are described by the Veneziano amplitude, between scattering particles. (auth)

3215 (NP-19047) STATISTICAL QUANTITIES IN PARTICLE COLLISIONS. Research Report No. 3/1971. Byckling, E.; Sohlo, S.; Suhonen, E. (Jyvaskyla Univ. (Finland). Dept. of Physics). May 1971. 20p. Dep. NTIS (U. S. Sales Only).

The statistical quantities for particle collisions are defined using the analogy between the phase space integral in multiparticle collisions and that in relativistic quantum statistical mechanics. The analogs of thermodynamic quantities are computed for the uncorrelated jet model. A relativistic derivation for the mass spectrum of hadrons is given and thermodynamic quantities are calculated for a system with this spectrum. (auth) (Finland)

3216 (NP-19050) "PARTON" OR "PHOTRON." A STRUCTURE OF ELECTRON, PROTON, NEUTRON, AND THE REMAINING ELEMENTARY PARTICLES. PHOTRON THEORY COMPREHENSION OF THE "WEAK INTERACTIONS" AND "STRONG NUCLEAR FORCE." Nowak, K. [1971]. 5p. (In German). Dep. NTIS (U.S. Sales Only).

Outlined is the photron theory developed in 1942. According to the theory, all matter consists of a single smallest particle, the photron, with a mass of 5.45×10^{-17} of the electron mass. These particles possess either a positive or a negative charge amounting to 1.37×10^{-11} of the electron charge e. The theory avoids the contradiction in Bohr's model of the atom by explaining atomic emissions and absorptions of photons. Matter irradiates in the form of photrons. Thus, the conservation laws of both matter and energy remain valid in the classical sense. (H.B.G.)

3217 (PAM-71-4) INDETERMINATION PROBLEMS IN MULTICHANNEL COLLISION THEORY. Benayoun, M.; Leruste, Ph. (College de France, Paris. Laboratoire de Physique Atomique et Moleculaire). Jun 1971. 25p. (In French). Dep. NTIS (U. S. Sales Only).

Some of the indetermination problems connected with the various multichannel scattering analyses are presented and the consequences of the off experiment indetermination, i.e., the indetermination resulting from the nonexistence of beams or targets of highly unstable particles (η, Σ, Λ ...). are examined. This indetermination generates in any model used, an infinite number of K-matrix parametrizations which cannot be distinguished from each other by any fitting of the data. The off experiment indetermination does not provide any change either in the T-matrix polology, or in the scattering lengths; but it involves an indefiniteness in the part of the residues relative to the channels not reached experimentally. Therefore every value of the coupling constants, relative to these channels and derived from the residues, can be arbitrarily multiplied by any complex constant without any change in the fitting of the data; this is true in the framework of any kind of phenomenological model (ZRA, ERA, CSL...). (France)

3218 MOTION OF DYONS. Rzazewski, K. (Univ., Warsaw). Acta Phys. Pol.; B2: No. 5, 707-11(Sep-Oct 1971).

The problem of motion of two dyons (particles with electric and magnetic charges) in relativistic classical mechanics is considered. It is shown that the Bohr–Sommerfeld quantization rules lead to an exact formula for energy levels. (auth)

3219 GRADIENT TERMS IN THE SCALAR-DENSITY–CHARGE-DENSITY COMMUTATOR. Zepeda, A. (Rockefeller Univ., New York). Phys. Rev., D; 4: No. 4, 1072-9(15 Aug 1971).

The one-meson-to-vacuum matrix element of the equal-time commutator of the charge density of a vector current and a scalar density is computed in the perturbative model of Johnson and Low. A gradient term is found. Consequences of this result for the dimensionality of the current components are discussed. (auth)

3220 ANALYTIC THEORY OF RELATIVISTIC INTERACTIONS. Kazes, E. (Pennsylvania State Univ., University Park). Phys. Rev., D; 4: No. 4, 999-1007(15 Aug 1971).

Based on the Lie algebra of the Poincaré group, a method for constructing relativistic interactions is proposed. This approach sheds light on previous difficulties and opens the way to the treatment of others that have resisted solution by the traditional approach. (auth)

3221 SEPARATION OF ANGULAR AND RADIAL VARIABLES IN THE WAVE EQUATIONS OF INTERACTING PARTICLES OF UNDEFINED SPINS. Jolivet, Andre (College Scientifique Univ., Angers, France). Ann. Inst. Henri Poincare, Sect. A; 14: No. 4, 335-51(1971). (In French).

First order, finite rank, linear systems of partial differential equations having an invariant form with respect to the orthochronous Lorentz group are used to describe a particle with an undefined spin interacting with an external field. Results previously obtained for these systems were applied to cases where the external interacting field has a spherical symmetry, and radial equations are easily obtained. In the study of particles in the framework of the fusion theory, new representations (such as the $GAMMA_4$ diagonal representation) are introduced, which lead to a simplification. For both a potential-type interaction and a $GAMMA_4$ diagonal representation, a system of radial equations consisting of two independant systems is obtained. (France)

3222 INTERACTIONS OF POLARIZED ELEMENTARY PARTICLES. Gabos, Z. Stud. Univ. Babes-Bolyai, Ser. Phys.; 16: No. 1, 47-51(1971). (In German).

Polarized particles with arbitrary spin and nonzero rest masses are examined. Such particles are generated by reactions between elementary particles. Drawing inferences from certain results for $s = 1/2$, the outcome is considered suitable for practical application. (tr-auth).

3223 PARAMETRIZATION OF VERTEX FUNCTIONS IN THE RARITA–SCHWINGER BASIS. Prokhvatilov, E. V. (Leningrad State Univ.). Teor. Mat. Fiz.; 9: No. 1, 65-79(Oct 1971). (In Russian).

The parametrization of scalar, pseudoscalar, vector and pseudovector vertex functions in the Rarita–Schwinger basis is considered, the invariant form factors being free of kinematical singularities and zeros. In the case of the vector vertex function the connection with the usual multipole decomposition is found. (auth)

3224 ALGEBRA OF CURRENTS AND GRADIENT TERMS. Mendes, R. V. (LFEN, Sacavem, Portugal); Ne'eman, Y. Ann. Phys. (N. Y.); 66: No. 2, 836-56(Aug 1971).

The observed hadron spectrum fits the quark picture or an $SU(6) \otimes L$ classification. It was proved in a previous publication that the integrated currents have to satisfy $SU(6) \otimes SU(6)$ commutation relations, if a connection with the spectrum is to be preserved. It is assumed that the corresponding local current components form a Lie algebra, including the required gradient terms. It is proven that this is impossible with c-number gradient terms. A solution is constructed in which the gradient terms involve additional density operators. These belong to an algebra

which is isomorphic to the local U(12) generated by the entire system of free triplet field bilinears. The physical algebra of local currents and gradient terms is given by a deformation of this local U(12). (auth)

3225 STATISTICALLY LINEAR MASS RELATION OF ELEMENTARY PARTICLES AND ITS REPRESENTATION BY A POLYNOMIAL CURVE FITTING EQUATION. Bhattacharjee, B. J. (St. Anthony's Coll., Shillong, India). Indian J. Phys.; 44: No. 1, 60 3(Jan 1970).

A number is ascribed for each elementary particle in the order of increasing mass. This number is plotted against the respective rest mass, and a parabolic curve is found. It is believed that the interpretation of the data indicates compelling evidence that the linear mass relation should be described by the given polynomial curve fitting equation. Analogies with the atomic weights of the elements plotted against the atomic numbers are pointed out. (J.F.P.)

3226 CORRELATION METHOD FOR ANALYSIS OF INELASTIC PROCESSES. Dremin, I. M.; Chernavskii, D. S. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 14: No. 2, 469-71(Aug 1971). (In Russian).

Five schemes and models for handling inelastic processes are listed and briefly discussed. A procedure is given for the treatment of experimental data and of artificial stars, as well. The particles of each star are arranged in the order of increasing longitudinal momentum. The squares of the transmitted momenta between particles were calculated. A correlation coefficient r_α was calculated using the given formula. For characterizing the aggregate of the stars under investigation, an "average" correlation coefficient, R_α, was computed. The properties of R_α are analyzed. (K.S.W.)

3227 COSMIC RAYS AND THE ELEMENTARY LENGTH. Kirzhnits, D. A.; Chechin, V. A. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 4, 172-4(20 Aug 1971).

[25]Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 4, 261-2(20 Aug 1971).

The nonobservation of a cut-off in the spectrum of primary cosmic ray particles leads to a question of whether the fundamental principles are violated. The violations due to the elementary length are confirmed by a model described in which the usual relativistic relations are violated. It is concluded that the characteristic length of the quantum theory of gravitation may play the role of elementary length. (J.F.P.)

3228 SUMMING SOFT MESONS. Ketley, I. J.; Martin, T. P.; Taylor, J. G. (Univ. of Soutampton, Eng.). Nucl. Phys.; B34: No. 2, 567-97(1971).

The applications of the relativistic eikonal approximation (REA) to summing the exchange of soft mesons with both rescattering and self-energy effects included are discussed using graphical techniques. This is done for heavy particles which are scalar or have spin one-half, and for mesons which are scalar, pseudoscalar or vector and may be neutral or charged. The dynamics is either an interaction of the Yukawa type with single meson emission from the heavy particle, or more generally of the non-polynomial Lagrangian type with sprays of mesons emitted or absorbed. The asymptotic behavior of such REA sums is discussed and finally a dipole vector meson fit is made to the nucleon electromagnetic form factor. (auth)

3229 FIXED-ANGLE LOWER BOUNDS FOR PRODUCTION AMPLITUDES AND INCLUSIVE EXPERIMENTS. White, A. R. (Cambridge Univ., Eng.). Nucl. Phys.; B34: No. 2, 367-85 (1971).

The application of the Cerulus–Martin theorem to production amplitudes is considered and a lower bound of the form e^{-Cs^γ} log s, $\frac{1}{2} \leq \gamma \leq 1$ is obtained in a certain subset of the fixed-angle limits of such amplitudes defined in a previous paper. The value of γ obtained depends on the assumptions made which are related to those of multi-Regge theory. It is also shown that the experimentally observed exponential decrease of inclusive differential cross sections in the fixed-angle, fixed scaled longitudinal momentum limit implies a similar decrease for production amplitudes in fixed-angle limits. As a result the lower bound derived for production amplitudes will also apply to inclusive differential cross sections in such a limit. (auth)

Electromagnetic

Refer also to abstracts 3416, 3426, and 3644.

3230 (CNRS-CPT-71-P-379) GALILEAN INVARIANCE AND MAGNETIC MONOPOLES. Bacry, H.; Kubar-Andre, J. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). Jun 1971. 13p. Dep. NTIS (U. S. Sales Only).

The existence of Dirac monopoles is shown to be incompatible with Galilean invariance. A discussion follows on the interpretation of monopoles physics in a Galilean approximation. (France)

3231 (COO-264-586) SPIN DEPENDENT INELASTIC ELECTRON-NUCLEON SCATTERING. Carlson, C. E.; Tung, Wu-Ki (Chicago Univ., Ill.). Sep 1971. 10p. (EFI-71-46). Dep. NTIS.

It is shown that the simultaneous measurement of the longitudinal and transverse polarization effects in deep inelastic lepton hadron scattering offers a practical way of determining the two spin dependent structure functions. These functions furnish interesting information on the spin dependence of scattering amplitudes at high energies as well as provide the natural testing ground for theoretical models based on light cone singularities, partons, etc. (auth)

3232 (COO-264-587) DEEP INELASTIC ELECTRON–PROTON AND ELECTRON–NEUTRON SCATTERING. Hacinliyan, Avadis (Chicago Univ., Ill.). Sep 1971. Contract AT(11-1)-264. 68p. (EFI-71-49). Dep. NTIS.

Formulas for the structure functions W_1 and W_2 are obtained using the statistical approach to the Veneziano model together with Pomeron dominance. A form for W_2 is obtained that scales and agrees well with the data. The question of the scaling of W_1 is discussed in relation to the available data. Phase space corrections and generalized Glauber corrections are then discussed in connection with e-d scattering. These corrections are found to be much smaller than the experimentally observed difference between the deuteron cross section and twice the free proton cross section. Hence, contributions from both the Pomeron and lower trajectories are used to generalize the model. Satisfactory agreement is obtained. (auth)

3233 (COO-264-588) MUON PAIR CREATION VIA TWO PHOTON EXCHANGE IN CHARGED PARTICLE COLLISIONS. Fujikawa, Kazuo (Chicago Univ., Ill. Enrico Fermi Inst.). Sep 1971. Contract AT(11-1)-264. 80p. (EFI-71-51). Dep. NTIS.

Muon pair creation via two photon exchange in charged particle collisions based on analytical QED formulas is discussed. For the electron colliding process the total cross section, the invariant mass distribution and the q^2-dependence of the cross section are given. These formulas are valid for electron energies larger than 1 GeV. Large q^2-behavior is studied in detail in connection with the deep inelastic process on the photon target. The present process shows an interesting "scaling" behavior and it is about an order of magnitude larger than the expected deep inelastic process. Also formulas for the muon pair bremsstrahlung process are derived. These formulas explicitly show various interesting properties observed in numerical calculation. The cross section of this process is small compared with that of the nearly on-shell two photon exchange process. However the result shows that the bremsstrahlung process may provide a serious background to the photon deep inelastic process at low energies. Also massive muon pair creation via two photon exchange in hadron collisions is discussed. The form factors of hadrons make the cross section very small at laboratory energies. This effect of form factors is discussed based on a numerical calculation. Based on a muon-parton analog, the ordinary deep inelastic process is also discussed, in particular, the q^2-dependence of the missing mass spectrum. (auth)

3234 (DEMO-71/17) IMPLICATIONS OF THE VENEZIANO MODEL ON VMD FOR THE ELECTROMAGNETIC FORM FACTORS. Gounaris, G. J. (Democritus Nuclear Research Center, Athens (Greece)). Jul 1971. 19p. Dep. NTIS (U. S. Sales Only).

The Frampton Veneziano-type model for the nucleon form factor is studied in detail. It is found that the predictions of the model for $F_1^V(t)$ and $F_1^S(t)$ are almost indistinguishable from the vector meson dominance predictions in the region of $0 < t < 0.8$ GeV^2. Consequently, these two models imply the same relations for the Dirac coupling constants of ρ, ω, and ϕ to the nucleon and the coupling to the photon. If the Frampton model has anything to do with reality, it also implies that no VMD assumption can be made for $F_2^V(t)$ and $F_2^S(t)$ even if we restrict ourselves to small regions around the ρ and ω. Finally, by making analogous assumptions for the pion form factor we argue that higher ρ-mesons (ρ', ρ'' etc.) are coupled much stronger to the nucleon than to the pion and that the pion form factor is vanishing asymptotically slower than the nucleon form factor. This suggests that it might be profitable to look for these mesons in backward production in π-N scattering, and provides an explanation of the difficulty to discover them up to now. (auth)

3235 (DESY-71/49) THEORETICAL INVESTIGATION OF THE REACTIONS $\gamma\gamma \to \pi\pi$ AND THE $\epsilon \to \gamma\gamma$ AND $f \to \gamma\gamma$ DECAY WIDTHS. Schierholz, G.; Sundermeyer, K. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Aug 1971. 31p. Dep. NTIS (U. S. Sales Only).

The $\gamma\gamma \to \pi\pi$ cross section and the $\epsilon \to \gamma\gamma$ and $f \to \gamma\gamma$ decay widths are calculated on the basis of partial-wave dispersion relations. The left-hand cut integral is approximated by vector meson exchange diagrams. On the right-hand cut elastic unitarity is taken into account which establishes a close correspondence between the cross section and the $\pi\pi$ phase shifts. The I = 0, J = 2 phase shift is parametrized in terms of the f(1260) and for the corresponding J = 0 phase shift a "down" and an "up" solution (ϵ Breit-Wigner) is considered. The cross section is found to depend sensitively on the form of the $\pi\pi$ final state interaction. The obtained $\epsilon \to \gamma\gamma$ and $f \to \gamma\gamma$ couplings are compared with other estimates. (auth)

3236 (EFI-TF-11(70)) SCHWINGER TERMS AND ANNIHILATION $e^+ + e^- \to$ HADRONS DUE TO CURRENT OF VECTOR MESONS. Ioffe, B. L.; Khoze, V. A. (Akademiya Nauk Armyanskoi SSR, Erevan. Institut Fiziki). 1970. 22p. Dep. NTIS (U. S. Sales Only).

The asymptotics at $E \to \infty$ of the total annihilation cross section $e^+ + e^- \to$ hadrons is considered on the assumption that the electromagnetic current of hadrons, j_μ, is the sum of currents of charged vector mesons, fermions with spin $\frac{1}{2}$ and bosons with spin 0. The asymptotics $\sigma(E)$ is determined by the Schwinger term, vacuum expectation value, of the equal-time commutator. It is shown that in the case of the vector meson current the limiting procedure, suggested by Schwinger, cannot be used for calculating this commutator since the result obtained does not agree with spectral representation. A method free from such contradictions for calculating this commutator by integrating in the momentum space is suggested. For the asymptotics of the annihilation cross section the result $\int^{\Lambda^2} \sigma(q^2)q^2dq^2 = a\Lambda^2 + \beta(\Lambda^4/\mu_0^2(\Lambda))$ is obtained, where $q^2 = 4E^2$, E is the energy $e^+(e^-)$ in C.M.S., μ_0 is the vector meson bare mass, a and b are the numerical coefficients. Whence it follows that when $E \to \infty$ $\sigma(E) \to \text{const}/E^\gamma$, where $2 \geq \gamma \geq 0$. (auth)

3237 (INP-762, pp 1-30) COHERENT PHOTON REACTIONS AND THE DIPION CONTINUUM. Bauer, T. H. (Daresbury Nuclear Physics Lab. (England)). Jun 1971.

In Proceedings of XI Cracow School of Theoretical Physics, Vol. I.

The dynamical role of charged pion pairs in forward high-energy photoproduction of charged pion pairs and ρ mesons and Compton scattering on nucleons and nuclei is considered. (J.F.P.)

3238 (INP-762, pp 246-308) ELECTRON EXCITATION OF NUCLEON RESONANCES. Walecka, J. D. (Stanford Univ., Calif. Inst. of Theoretical Physics). Jun 1971.

In Proceedings of XI Cracow School of Theoretical Physics, Vol. I.

The discussion of electron excitation of nucleon resonances covers the general analysis, and also relativistic and classical field models. Some previous experimental results are also included. (J.F.P.)

3239 (NYO-3829-78) BILOCAL ALGEBRA AND DEEP INELASTIC e-p SCATTERING. Yao, T.; Mahanthappa, K. T. (International Centre for Theoretical Physics, Trieste (Italy)). Jul 1971. Contract AT(30-1)-3829. 15p. Dep. NTIS.

For Pittsburgh Univ., Pa. Dept. of Physics.

It is demonstrated that current conservation coupled with the bilocal algebra as formulated by Fritzsch and Gell-Mann (FGM) leads to nonscaling corrections to the structure functions of inelastic e-p scattering and, furthermore, these functions are expressible in terms of a single function. This leads to a sum rule between differences of the structure functions and an expression for R (the ratio of longitudinal to transverse cross sections) which forbids it to be a constant. These provide a stringent test of the FGM algebra when the improved experimental data becomes available. It is also remarked on the implication of a similar analysis to inelastic ν-p scattering. (auth)

3240 (NYO-4204-21) SOME THEORETICAL ASPECTS OF COLLIDING e^+-e^- BEAMS. Pais, A. (Rockefeller Univ., New York). [1971]. Contract AT(30-1)-4204. 15p. (CONF-710609-10). Dep. NTIS.

From International conference on elementary particles; Amsterdam, Netherlands (30 Jun 1971).

Two kinds of somewhat off-beat future experiments for which colliding positron-electron beams are particularly suited are described. First, the usefulness of these facilities for tests of C-invariance at high energy are reviewed. The second topic concerns the application of PCAC and current algebra notions at high energies, where e^+-e^- annihilations give transparent tests for seeing whether or not PCAC is applicable. (R.W.R.)

3241 (UCRL-51050) SCHWARZ-HORA EFFECT: BUNCHING OF DIRAC CHARGED PARTICLES BY MONOCHROMATIC AND ENVELOPE-MODULATED LASER BEAMS. Bevensee, R. M. (California Univ., Livermore. Lawrence Radiation Lab.). 6 May 1971. Contract W-7405-eng-48. 33p. Dep. NTIS.

The generalized wave equation for a charged particle in an electromagnetic field (treated classically) is derived from the Dirac equation. The Varshalovich-D'yakonov expression for the wave function of an electron momentum component (nonrelativistic approximation) in a monochromatic field is generalized to the case of arbitrary angle between electric field vector and direction of average electron momentum. First-order corrections are added to obtain the wave function satisfying the relativistic associated Klein-Gordon equation. The momentum components ψ_k in nonrelativistic approximation are integrated to yield the behavior of the total wave function ψ of the electron wavepacket. The density function $\psi^*\psi$, proportional to charge density and current, is evaluated and examined for frequency harmonic content as a function of position. A "triangular rule" is developed to describe the behavior of $\psi^*\psi$ after two successive modulations of the wavepacket by two independent laser beams. For slow (narrow band) envelope modulation of the laser beam, it is shown how the modulation is impressed upon $\psi^*\psi$ ("adiabatic" approximation). A novel electron diffraction scheme is proposed for demodulating the electron current and recovering the original envelope modulation on the laser beam. Finally, the question of the "force" exerted upon a wavepacket is examined, both for strongly localized and poorly localized wavepackets. (auth)

3242 SEMICLASSICAL PICTURE OF THE ELECTRON SPIN. Lee, A. R.; Liesegang, J. (La Trobe Univ., Victoria, Australia). Phys. Lett.; 37A: No. 1, 37-8(25 Oct 1971).

By postulating that the spin angular frequency of the electron is related to its rest energy by $\omega_0 = m_0c^2/\hbar$, one arrives at a value for the radius of the electron, equal to its Compton wavelength $\lambda_C = \hbar/m_0c$. An assumed spherically symmetrical mass and charge density distribution of the form $\rho_m \propto \rho_e \propto r^3$ then results in a spin angular momentum of $S = \frac{1}{2}\hbar$ and a magnetogyric ratio of $\mu/S \simeq 1.055\ e/m_0$. (auth)

3243 INELASTIC e-p SCATTERING IN MASSIVE QUANTUM ELECTRODYNAMICS. Fishbane, P. M.; Sullivan, J. D. (Univ. of Illinois, Urbana). Phys. Lett.; 37B: No. 1, 68-70(1 Nov 1971).

The leading contributions to νW_2 in the neutral vector gluon model are calculated in the deep inelastic region. Scaling is broken by $\ln Q^2$ factors which come from both transverse and longitudinal phase-space integrations and which exponentiate. (auth)

3244 DEEP INELASTIC ELECTRON SCATTERING IN PERTURBATION THEORY. Gribov, V. N.; Lipatov, L. N. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett.; 37B: No. 1, 78-80(1 Nov 1971).

Deep inelastic ep scattering and deep inelastic annihilation cross sections have been found in vector and pseudo-scalar meson theories assuming the coupling constant $g^2 \ll 1$ but $g^2 \ln q^2 \sim 1$. It is shown that in a vector theory, despite a rapid drop of electromagnetic form factors, the ep deep inelastic scattering amplitudes increase with q^2 at fixed ω. (auth)

3245 SOFT PION PRODUCTION IN DEEP INELASTIC ELECTROMAGNETIC AND WEAK PROCESSES. Ioffe, B. L. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett.; 37B: No. 1, 101-4(1 Nov 1971).

On the basis of the PCAC hypothesis and current algebra, the cross section of one and two soft pion production in the deep inelastic scattering of electrons and neutrinos on nucleons is calculated. The experimental measurement of these processes would make it possible to investigate the one-nucleon matrix elements of the axial and isovector current commutators and contribute to elucidation of the scale invariance mechanism. (auth)

3246 IS THERE A FIXED POLE IN ρ PHOTOPRODUCTION. Brandt, R. A. (New York Univ., N. Y.); Ng, Wing-chiu; Vinciarelli, P.; Preparata, G. Lett. Nuovo Cim.; 2: No. 18, 937-40 (30 Oct 1971).

Theoretical and indirect experimental support is found for the presence of a J = 0 fixed pole in ρ photoproduction. (L.B.S.)

3247 PION FORM FACTOR FROM PARTIALLY UNITARIZED HARD-PION CURRENT ALGEBRA. Ecker, G. (CERN, Geneva). Nuovo Cim.; 6A: No. 1, 1-12(1 Nov 1971).

Using a consistency condition for the transverse part of the primitive AAV-vertex function, the electromagnetic form factor of the pion is derived from partially unitarized hard-pion current algebra and the Schnitzer–Weinberg parametrization (δ-model). The result is in very good agreement with the Orsay measurements and in good enough agreement with the scarce data for spacelike arguments. The difference between the position of the peak of the form factor and the resonance energy is discussed. (auth)

3248 INVESTIGATION OF THE ELECTROPRODUCTION OF THE NUCLEON RESONANCES ON POLARIZED PROTONS. Sokolov, A. A. (Moscow State Univ.); Kerimov, B. K.; Sadykhov, F. S.; Muchtarov, A. I. Nuovo Cim.; 6A: No. 1, 13-20(1 Nov 1971).

The inelastic scattering of electrons on polarized protons is considered in the one-photon approximation. An expression for the cross section is derived by taking into account the polarization of the scattered electron and the quadrupole (E2) and magnetic-dipole (M1) form factors of the transition in the γpN^* vertex. It is shown that the contribution to the cross section from particle polarization is sensible, but nearly constant when the scattering angle runs in the range $18° \leq \theta \leq 35°$. In addition, it is pointed out that the supplementary contribution to the cross section for inelastic scattering on polarized target is about 30% of inelastic scattering cross section on an unpolarized target. It is shown that the angular behavior of the correlation degree of this phenomenon is completely different from that of the elastic process. (auth)

3249 FOURTH-ORDER RADIATIVE CORRECTIONS TO ELECTRON–PHOTON VERTEX AND THE LAMB-SHIFT VALUE. Barbieri, R. (Scuola Normale Superiore, Pisa, Italy); Mignaco, J. A.; Remiddi, E. Nuovo Cim.; 6A: No. 1, 21-8(1 Nov 1971).

The slope of the charge form factor of the electron is analytically evaluated in fourth-order perturbation theory of QED and found to be $m^2F_1'(0) = (\alpha/\pi)^2[-4819/5184 - (49/72)\zeta(2) + 3\zeta(2)\log 2 - (3/4)\zeta(3)] = (\alpha/\pi)^2 \cdot 0.470$. Correspondingly the theoretical Lamb-shift value for the hydrogen atom is $\Delta\nu(2S_{\frac{1}{2}} - 2P_{\frac{1}{2}}) = (1057.90 \pm 0.09)$ MHz, in agreement with experiments. (auth)

3250 CALCULATION OF ELECTROMAGNETIC SHOWERS IN LEAD WITH AN INITIAL ENERGY OF 20 GeV. Varfolomeev, A. A.; Drabkin, L. B. Kosm. Luchi; No. 12, 174-206(1970). (In Russian).

The Monte Carlo method was used to calculate the spatial development of electromagnetic showers in lead from the reactions of 20-GeV electrons. Values are given for properties of the showers. (J.F.P.)

3251 SCALING PROPERTIES IN INELASTIC ELECTRON SCATTERING WITH A FIXED FINAL MULTIPLICITY. Lee, T. D. (Columbia Univ., New York). Ann. Phys. (N. Y.); 66: No. 2, 857-67(Aug 1971).

The scaling property of inelastic electron scattering with a fixed final hadron multiplicity is analyzed. The relation between the structure functions and the average multiplicity at infinite energy is discussed. A possibility exists that, if all soft mesons are excluded, the remaining hadron multiplicity at infinite energy may stay finite and not too high, in which case some insight may be gained as to why the observed structure functions appear to scale at a relatively low energy. By using the tree diagrams of the usual SU_2 phenomenological Lagrangian, explicit calculations of the structure functions W_1 and νW_2 are made for all two-body final channels, such as $p\pi^0$, $n\rho^+$, etc.; it is found that, in this simple model, the scaling property is satisfied for these particular channels. Possible experimental consequences are discussed. (auth)

3252 STRANGENESS ANALOG RESONANCES. Kerman, A. K. (Massachusetts Inst. of Tech., Cambridge); Lipkin, H. J. Contract AT(30-1)-2098. Ann. Phys. (N. Y.); 66: No. 2, 738-57(Aug 1971).

Strangeness analog resonances in hypernuclei are defined by analogy to the well-known isobaric resonances. Their relationship to the Sakata SU(3) model is discussed. Estimates are made for their energies and total widths. It is suggested that the excited states of ${}_{\Lambda}C^{12}$ and ${}_{\Lambda}N^{14}$ seen in stopped-kaon experiments are examples. (auth)

3253 ASYMPTOTIC SUM RULE IN PERTURBATION THEORY. Corrigan, Dennis (Univ. of California, Los Angeles). Phys. Rev., D; 4: No. 4, 1053-9(15 Aug 1971).

The sum rule which relates the longitudinal cross section in high-energy electron-proton scattering to the Schwinger term in the commutator of the electromagnetic current with itself is investigated in perturbation theory. Various nonperturbative derivations of the sum rule are first reviewed. Then, in second-order perturbation theory (using the gluon model), the failure of the sum rule is shown to be a consequence of the violation of certain of the assumptions which underlie the nonperturbative derivations. (auth)

3254 CURRENT COMMUTATORS NEAR THE LIGHT CONE. Gross, David J. (Princeton Univ., N. J.). Phys. Rev., D; 4: No. 4, 1130-41(15 Aug 1971).

The behavior of nonforward matrix elements of current commutators near the light cone is discussed. In momentum space this is equivalent to an investigation of the absorptive part of nonforward Compton scattering in the scaling (Bjorken) limit. Starting from the assumption that the forward absorptive part scales, as indicated by the experiments on inelastic lepton–proton scattering, it is shown that all nonforward helicity amplitudes are bounded by functions which approach finite limits in the scaling region. The nonforward structure functions in this limit are functions of the scaling variable, the momentum transfer, and the finite mass difference of the currents. The restrictions placed on these functions due to causality are derived by using the Jost–Lehmann–Dyson representation. It is shown that the scaling structure functions are independent of the mass difference of the currents. A light-cone representation is derived which exhibits the singular part of the current commutator in terms of the structure functions. The operator-product expansion for the current commutator near the light cone is introduced and the nature of operators contributing to the scaling region is discussed. These operators, which are the highest-spin components of the equal-line commutators of the current with itself, are expressed in terms of moments of the structure functions with respect to the scaling variable. Various inequalities for the form factors of these operators are derived from unitarity. An analytic function of angular momentum is constructed which interpolates the highest-dimension operators in the light-cone expansion. It is argued that due to the locality of these operators the interpolating operator contains the singularities in angular momentum that are present in the strong interactions. This implies that the structure functions have Regge behavior in the scaling limit. (auth)

3255 WEAK AND ELECTROMAGNETIC FORM FACTORS FROM A DUAL RELATIVISTIC QUARK MODEL. Venturi, G. (Univ., Bologna). Lett. Nuovo Cim.; 2: No. 17, 857-62(23 Oct 1971).

It is shown how predictions for the weak and electromagnetic baryon octet–octet and decuplet–octet transition form factors may be obtained from a dual relativistic quark model. It is also indicated how dual relativistic quark model amplitudes involving conserved and partially conserved currents may be constructed. (L.B.S.)

3256 S-MATRIX DERIVATION OF THE MOTION OF AN ELECTRON IN A CLASSICAL ELECTROMAGNETIC FIELD. Stapp, H. P. (Univ. of California, Berkeley). Nuovo Cim.; 5A: No. 4, 619-30(21 Oct 1971).

It is shown how the motion of an electron in a given external classical electromagnetic field is derived from S-matrix principles. (auth)

3257 QUANTUM-MECHANICAL EFFECT WITHOUT FORCE FOR SPINNING PARTICLES. Hrasko, P. (Central Research Inst. for Physics, Budapest). Lett. Nuovo Cim.; 2: No. 16, 832-4(16 Oct 1971).

An experiment involving neutral particles with magnetic moment is described, where the particles can be viewed to move classically along the trajectories unperturbed by any force, while changes in the phase of the wave function lead to observable effects. (L.B.S.)

3258 ELECTROMAGNETIC CORRECTIONS TO THE TOTAL CROSS SECTIONS OF HADRON INTERACTIONS. Savrin, V. I.; Tyurin, N. E.; Khrustalev, O. A. (High-Energy Physics Inst., Serpukhov, USSR). Teor. Mat. Fiz.; 9: No. 1, 60-4(Oct 1971). (In Russian).

The contribution of the electromagnetic interaction into the difference of total cross sections of particles and antiparticles is calculated on the basis of the relativistic equation of the quantum theory of damping. (auth)

3259 ELEMENTARY ALGEBRA OF THE EUCLIDEAN GROUP, WITH APPLICATION TO MAGNETIC CHARGE QUANTIZATION. Peshkin, M. (Argonne National Lab., Ill. Kyoto Univ). Ann. Phys. (N. Y.); 66: No. 2, 542-7(Aug 1971).

A simple treatment of the algebra of the Euclidean group E3 is based on the introduction of a second group of rotations. Dirac's quantization of magnetic charge appears as the quantization of the generator of rotations about the axis connecting the electric and magnetic charges. (auth)

3260 COMPOSITE MODELS OF THE BARYONS AND ELECTROMAGNETIC DECAYS. Kisslinger, L. S. (Carnegie-

Mellon Univ., Pittsburgh. Los Alamos Scientific Lab., N. Mex.); Feshbach, Herman. Contract AT(30-1)-2098. Ann. Phys. (N. Y.); 66: No. 2, 651-73(Aug 1971).

Using a variety of models, the possible electromagnetic decays of the baryon resonances with known quantum numbers are estimated. The results suggest that in many cases the radiative transitions will compete strongly enough with the strong decays to permit their observation. It is also observed that such experiments can be quite fruitful in selecting between models and helping determine the structure of the particles. (auth)

3261 METHOD TO CALCULATE SUBTRACTION CONSTANTS APPLICATION TO THE $\eta \to \pi^0 \gamma\gamma$ PROBLEM. Gounaris, G. J. (CERN, Geneva. Democritus Nuclear Research Center, Athens); Verganelakis, A. Nucl. Phys.; B34: No. 2, 418-28(1971).

It is demonstrated that the duality finite energy sum rule method to take into account high mass contributions to amplitudes at low energy and momentum transfer essentially determines the subtraction constant. The method therefore has to be used whenever one of the amplitudes does not accept unsubtracted dispersion relations. Using this method $[\Gamma(\eta \to \pi^0\gamma\gamma)]/[\Gamma(\eta \to 2\gamma)] = (5 \pm 3)\%$ is predicted. Such a result seems to be favored by recent experiments and moreover is bigger by a factor 80 than the usual vector meson dominance prediction. Comments about $\omega \to 3\pi$ and $X \to \pi^0\gamma\gamma$ are also made. (auth)

3262 REMARKS ON OFF SHELL $\rho\pi$ SUM RULES AND APPLICATIONS TO π AND K ELECTROMAGNETIC MASS DIFFERENCES. Hall, G. S.; Osborn, H. (Univ. of Glasgow). Nucl. Phys.; B34: No. 2, 445-69(1971).

The various current algebra sum rules for virtual isovector photons scattering on pions with I = 1,2 in the t-channel are studied with a view to saturation by the π, ω and A_1 intermediate states. A consistent set of ρ dominated form factors are found which reproduce the strong coupling constants of Gilman and Harari. These form factors are used in a calculation of the π electromagnetic mass difference which automatically contains the current algebra result. Analogous form factors are chosen in a calculation of the K e.m. mass difference which includes a re-evaluation of the FESR for the high-energy A_2 contribution. Some remarks are also made about the relevance of the deep inelastic scaling region and it is shown how its contribution to the overall e.m. mass shift might be finite. (auth)

3263 KINEMATICS OF $\gamma\gamma$ SCATTERING. Budnev, V. M.; Chernyak, V. L.; Ginzburg, I. F. (Mathematical Inst., Novosibirsk, USSR). Nucl. Phys.; B34: No. 2, 470-6(1971).

The kinematics of $\gamma\gamma$ scattering is studied—a process which is accessible to experimental study. Two sets of invariant amplitudes are given. One of them corresponds to the s-channel helicity amplitudes (cross section for the scalar and transversal photons). The second one is a combination of t-channel helicity amplitudes with the high-energy asymptotic behavior as low as possible. Asymptotic behavior for each amplitude is given in the simple Reggepole model. The possibility for fixed singularities to appear in the imaginary part of the amplitude is pointed out. (auth)

3264 LEPTON–HADRON SCATTERING AND ELEMENTARY PARTICLES. Senju, Hirofumi (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 46: No. 2, 550-8(Aug 1971).

A new model of elementary particles is proposed, which leads to a quartet model with strangeness spin. The model explains the data on deep inelastic electron scattering surprisingly well, if the parton picture is assumed. It is predicted that the mean square charge per parton equals $\frac{1}{6}$ in all hadrons and that, using sum rule, $\nu W_2^p/M^2$ varies as $1/\sqrt{\omega}$ for large ω. Under some assumptions it can be shown that $\nu W_2^p/M^2 = 105/64 \cdot (\omega - 1)^3/\omega^{3.5}$ and $\nu W_2/M_\pi^2 = 8/3\pi \cdot (\omega - 1)^{1.5}/\omega^2$. (auth)

3265 INFINITELY-DEGENERATE PARTICLES AND MECHANISM OF MASS SPLITTING. FERMION CASE. Miyazaki, Tadashi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 2, 659-63(Aug 1971).

Starting with the system of particles with the same common mass but with various different spins, the masses are split based on the tadpole interaction. In this way all the defects of the theory of infinite multiples are remedied. An idea proposed, in the boson case, (Prog. Theor. Phys. 44: 796 (1970)) is extended to the fermion case. As previously mentioned, the defects of the theory of infinite multiplets, namely the existence of space-like solutions, the violation of CPT invariance, the violation of the relation between spin and statistics and especially the well-known no-go theorem have rejected the usual method of quantization based on the canonical formalism. The following idea was proposed: First one treats the case in which all the particles have the same common mass but different various spins, and next introducing a new scalar particle Q, one makes the masses of the particles split with respect to the spins. Along this line of thought all the defects can be evaded. An example of the boson case is easily obtained. (auth)

3266 ELECTROMAGNETIC MASS DIFFERENCE OF PION. Chia, T. C. (Dalhousie Univ., Halifax, Nova Scotia). Progr. Theor. Phys. (Kyoto); 46: No. 2, 672-3(Aug 1971).

The method of Minanaikawa et al. (Prog. Theor. Phys. 43: 742 (1970)) for computing the π electromagnetic mass difference is extended to include the coupling of the photon to all vector mesons. It is shown that, under a certain assumption, this amounts to using both the Veneziano-type form factor and the Veneziano amplitude in the Cottingham formula. (L.B.S.)

Weak

Refer also to abstracts 3373 and 3380.

3267 (NYO–3829-73) RELATIVISTIC TWO-VARIABLE EXPANSIONS FOR THREE-BODY DECAY AMPLITUDES. Hicks, H. R. (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Physics); Winternitz, P. (Pittsburgh Univ., Pa. Dept. of Physics). Jul 1971. Contract AT(30-1)-3829. 39p. Dep. NTIS.

Three body decays $1 \to 2 + 3 + 4$ are considered using a frame of reference analogous to the cms for scattering. The physical decay region is mapped onto an 0(4) sphere, so that the decay amplitude $f(\alpha,\theta)$ is a function on this sphere (depending only on two of the three angles α, θ and ϕ). The amplitude is then expanded in terms of the basis functions of 0(4) and one obtains two-variable expansions, in which all the dependence on the kinematic parameters is explicitly displayed in special functions. These expansions make it possible to treat decays and scattering on the same footing, in that they are intimately related to 0(3,1) expansions of scattering amplitudes, considered previously. Some analyticity properties are built in, so that each partial wave has the correct behavior at the threshold $(m_3 + m_4)^2$ and pseudothreshold $(m_1 - m_2)^2$. The expansions make it possible to perform a kinematically (or group theoretically) motivated harmonic analysis of Dalitz plot distributions for $K \to 3\pi$ and $\eta \to 3\pi$ decays. (auth)

3268 (RLO–2041-60) WEAK PRODUCTION OF NUCLEON RESONANCES. Zucker, P. A. (Oregon Univ., Eugene. Inst. of Theoretical Science). Jun 1971. Contract AT(45-1)-2230. 137p. Dep. NTIS.

A dynamical and fully-covariant model for the weak production from nucleons of the N*(1256) and higher mass resonances is presented. The analytic structure and unitarity of the partial wave helicity amplitudes are incorporated in this model which has a simple N/D form. Above the $\pi\pi N$ threshold the excitation and rescattering of hadronic eigenstates are considered. For the excitation mechanism one uses pion, nucleon, and vector meson exchange. By using the conserved vector current theory and a previous calculation for electroproduction, all the necessary normalizations, which result from the final-state enhancement factors are ascertained beforehand, and thereby an absolute calculation for weak production is performed. Predictions are given for the differential and total cross sections in the first four resonance regions, and a favorable comparison is made with the existing data from CHRN. The results for the N*(1236) are considerably different from the predictions made by Adler in a calculation which treats that one resonance. Since the cross section formulas are derived keeping all dependence on the lepton mass, one can examine the interesting behavior as the forward direction is approached. The partially conserved axial current hypothesis, its implications for resonance production, and the role of the model in designing a test of it are also discussed. (auth)

3269 (UCLA-1064) STUDY OF THE STRONG INTERACTION FORM FACTORS FOR $K_L^0 \to \pi\mu\nu$ AND $K_L^0 \to \pi e\nu$. Dally, E.; Innocenti, P.; Seppi, E. (Stanford Linear Accelerator Center, Calif.); Chien, C.-Y.; Cox, B.; Ettlinger, L.; Resvanis, L.; Zdanis, R. A. (Johns Hopkins Univ., Baltimore, Md.); Buchanan, C. D.; Drickey, D. J.; (and others) (California Univ., Los Angeles). [1971]. 21p. (JHU–7107). Dep. NTIS.

The strong interaction form factors were extracted from K_{e3}^0 and $K_{\mu 3}^0$ data of a previously reported K_L^0 experiment in a manner which does not assume an explicit $q^2 = (p_K - p_\pi)^2$ dependence. The unparameterized $f_+(q^2)$ from these two decay modes agree within statistical error as demanded by μ-e universality. The unparameterized form factors $f_+(q^2)$ from the $K_L^0 \to \pi e\nu$ and $K_L^0 \to \pi\mu\nu$ modes and $f_-(q^2)$, $f_0(q^2)$, and $\xi(q^2)$ dependences extracted from the $K_L^0 \to \pi\mu\nu$ data are presented. A comparison of these unparameterized results is made with the results of the Dalitz plot analyses in which various functional forms are assumed for the q^2 dependence of the form factors. (auth)

3270 MEASURING CHIRAL SYMMETRY BREAKING IN NEUTRINO SCATTERING. Mandula, J.; Schwimmer, A.;

Weyers, J.; Zweig, G. (California Inst. of Tech., Pasadena). Phys. Lett.; 37B: No. 1, 109-13(1 Nov 1971).

The ideas of broken scale invariance and operator light cone expansions are used to relate the scale dimension of the chiral symmetry breaking part of the strong interaction Hamiltonian to the energy dependence of the form factors W_4 and W_5 in the deep inelastic region of neutrino scattering. The possibility that neutrino scattering may be used to measure the scale dimension of the chiral SU(3) ⊗ SU(3) breaking Hamiltonian is pointed out. (auth)

3271 CURRENT ALGEBRA SUM RULES AND DUALITY IN INELASTIC LEPTON–NUCLEON SCATTERING. Riazuddin (Univ. of Maryland, College Park); Fayyazuddin. Lett. Nuovo Cim.; 2: No. 18, 941-6(30 Oct 1971).

Predictions for the threshold behavior of the structure function and form factors for neutrino reactions are obtained by using the current algebra sum rules of Adler and Bjorken and the scaling properties of the structure functions. The results are similar to those obtained by using the duality concept and a finite-energy sum rule. (L.B.S.)

3272 UNIVERSAL WEAK INTERACTIONS INVOLVING HEAVY LEPTONS. Tsai, S. Y. (Nihon Univ., Tokyo). Lett. Nuovo Cim.; 2: No. 18, 949-52(30 Oct 1971).

The possibility is considered that $h^{\pm}$, or $(h^-,\bar{\nu}_h)$, or (h^+,ν_h) might exist, which possess the same second lepton number with (μ^-,ν_μ) and $(\mu^+,\bar{\nu}_\mu)$, and which participates in the universal electromagnetic and weak interactions. A scheme is proposed from which the partial decay rates for $h \to e\nu\bar{\nu}$, $h \to \mu\nu\bar{\nu}$, and $h \to \pi\nu$ are computed. (L.B.S.)

3273 ANALYTIC PROPERTIES OF THREE-BODY DECAY AMPLITUDES. Amado, R. D. (Univ. of Pennsylvania, Philadelphia); Freeman, David F.; Rubin, Morton H. Phys. Rev., D; 4: No. 4, 1032-8(15 Aug 1971).

The nature and location of the physical singularities of a weak three-body decay amplitude are studied in perturbation theory (nonrelativistic). Only the threshold singularities one would expect are found. These are most easily expressed if final momentum variables are scaled by the total energy. (auth)

3274 SECOND-CLASS CURRENTS, NEUTRAL CURRENTS, AND THE STRANGENESS-CONSERVING NONLEPTONIC WEAK INTERACTIONS. Herczeg, P. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., D; 4: No. 4, 1239-43(15 Aug 1971).

The isospin structure of the strangeness-conserving nonleptonic weak Hamiltonian constructed from products of octets of vector and axial-vector currents is investigated in the presence of charged and neutral currents of both regular and irregular behavior under charge conjugation. It is shown that in a CP-invariant theory an isospin-invariant Hamiltonian is possible only in the absence of charged second-class currents. (auth)

3275 ORIGINS OF MUONS WHICH STOP UNDERGROUND. Adair, R. K. (Brookhaven National Lab., Upton, N. Y. Yale Univ., New Haven). Lett. Nuovo Cim.; 2: No. 17, 891-4(23 Oct 1971).

It is shown that plausible models for the photoproduction of pions by the electromagnetic field of fast muons lead to the conclusion that most muons which stop deep underground are secondary muons originating from the decays of pions produced in these photoproduction processes. The rate at which primary muons stop in a detector, divided by the flux through the detector, is found to be independent of the depth of the detector at great depths. (L.B.S.)

3276 ELECTROMAGNETIC EFFECTS IN THE DECAY OF POLARIZED NEUTRONS. Shann, R. T. (Univ. of Sussex, Brighton, Eng.). Nuovo Cim.; 5A: No. 4, 591-6(21 Oct 1971).

A finite, model-independent function $h(E,E_0,m)$ is found which, together with the Sirlin function $g(E,E_0,m)$, gives the energy dependence of the electron spectrum in the decay of polarized neutrons. Applied to asymmetry data, these functions determine a value for the ratio of the effective weak-coupling constants. This value is compared with an existing determination of the same quantity from decay data. (auth)

3277 RESOLUTION OF THE DISCREPANCY IN THE DETERMINATION OF THE CABIBBO ANGLE θ_V FROM K_{l3} AND NUCLEAR β DECAYS. Fischbach, Ephraim (Purdue Univ., Lafayette Ind.); Nieto, Michael Martin; Primakoff, Henry; Scott, C. K.; Smith, Jack. Phys. Rev. Lett.; 27: No. 20, 1403-6(15 Nov 1971).

The magnitude of the polar-vector Cabibbo angle θ_V obtained from K_{e3} decay was reevaluated using the Kemmer description of pseudoscalar mesons. The value $\theta_V^{(K)} = 0.192_+ \pm 0.016$ is found. This compares favorably with the value $\theta_V^{\beta} = 0.188_- \pm 0.007$ obtained for $0^+ \to 0^+$ β decays, and thus removes the discrepancy between $\theta_V^{(\beta)}$ and the value obtained from the conventional Klein–Gordon K_{e3} description, $\theta_V^{(K\text{-}G)} = 0.235_- \pm 0.019$. Combining the Kemmer and the β-decay results lead to a "best" value of $\theta_V = 0.188_+ \pm 0.006$. A new determination of the axial-vector Cabibbo angles $\theta_A^{(K)}$ and $\theta_A^{(K\text{-}G)}$ is also obtained. (auth)

3278 $\Delta S \to 2$ TRANSITIONS IN NONLEPTONIC HYPERON DECAYS. Konuma, Michiji, Kurata, Koji; Sugano, Kimio (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 2, 527-33 (Aug 1971).

In order to explain the phenomena of CP violation using the current-current interaction, several authors, including one of the present authors (M. K.), have introduced a neutral current in the form of the universal V–A current-current interaction. Then there appears a part in the Hamiltonian to produce the $\Delta S = 2$ transition in first order. The nonleptonic hyperon decays with $\Delta S = 2$, $\Xi \to N\pi$, are treated, and decay rates and asymmetry parameters are obtained using both the above interaction and the second order effect of the usual current-current interaction. In the latter case use is made of the baryon pole model. Comparison between the two calculations shows that there is a possibility of a considerable change in the asymmetry parameters of the decays $\Xi \to N\pi$ in the presence of the above-mentioned neutral current. (auth)

3279 NONLEPTONIC HYPERON DECAYS. I. Konno, Kimiaki; Nakamura, Katsuya (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 46: No. 2, 534-41(Aug 1971).

Nonleptonic hyperon decays are studied in the framework of new s-u symmetry and absence rule for an octet spurion. It is shown that the Lee–Sugawara relation is derived from the symmetry instead of R (or RP) reflection for parity conserving decay amplitudes, and from the absence rule in t channel for parity violating decay amplitudes, and that the characteristic properties of decay amplitudes especially appearing in Σ-decay modes are well reproduced. (auth)

3280 RESONANCE DOMINANCE IN NONLEPTONIC HYPERON DECAY. Kikugawa, Hiroyuki (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 2, 542-9(Aug 1971).

On the basis of the PCAC hypothesis and the use of a particular soft pion limit, it is shown that the baryon octet intermediate states lead to $A(\Sigma_\delta^+) = B(\Sigma_\delta^+) = 0$, $A(\Sigma^-) = A(\Sigma_\delta^+)$, $B(\Sigma^-) = B(\Sigma_\delta^+)$ provided that electromagnetic mass differences are neglected. Thus, it is inevitable to include contributions from higher excited states. A simple model in which the $\frac{1}{2}^-$ octet (nonet) and $\frac{1}{2}^+$ octet (nonet) resonances dominate is given. The Lee–Sugawara relation is the consequence of this model. (auth)

3281 MIRROR ASYMMETRY, MESON EXCHANGES, AND SECOND CLASS CURRENTS. Delorme, Jean; Rho, Mannque (CEN de Sacaly, Gif-sur-Yvette, France). Nucl. Phys.; B34: No. 2, 317-48(1971).

The consequences on nuclear beta decay of the possible existence of second-class axial currents in weak interaction are explored. It is found that due to off-mass-shell and meson-exchange complications, the beta-decay rates–for instance, the mirror asymmetries–cannot yield unambiguous information on the second-class coupling, unless one has some knowledge of the divergence of the current. If it is assumed that the divergence vanishes, then the off-shell ambiguity can be eliminated through a low-energy theorem and the meson-exchange corrections uniquely determined so that the mirror asymmetries can yield direct information on the fundamental second-class coupling. As a result of the divergence-equals-zero hypothesis, the meson-exchange effect which is essential for the elimination of the ambiguity turns out to have the same energy dependence as the impulse contribution. An interesting relation connecting the coupling constant for the semi-leptonic decay of ω into a soft pion to the pion exchange contribution to the mirror asymmetry is obtained. Finally a few experiments are reviewed which have a direct bearing on the existence or non-existence of the second-class axial coupling free of the off-shell and meson-exchange complications and which can eventually support or rule out our hypothesis. (auth)

Strong (General)

Refer also to abstracts 3206, 3410, and 3435.

3282 (INP–763, pp 55–73) BACKGROUNDS TO ONE-PION EXCHANGE IN DIPION PRODUCTION. Morgan, David (Rutherford High Energy Lab., Chilton (England)). 1971.

In Proceedings of the XI Cracow School of Theoretical Physics, Volume II.

A brief review of some aspects of one-pion-exchange backgrounds is given for dipion production. (J.F.P.)

3283 (INP–763, pp 96–120) BETHE–SALPETER EQUATION WITH A HARMONIC OSCILLATOR POTENTIAL. Sundaresan,

M. K. (Carleton Univ., Ottawa (Ontario)). 1971.
In Proceedings of the XI Cracow School of Theoretical Physics. Volume II.

Some results of investigations with the Bethe–Salpeter equation for the bound states of a quark–antiquark pair using a relativistic generalization of the harmonic oscillator interaction are presented. The scalar and spinor cases are considered. (J.F.P.)

3284 RANDOM FLIGHTS AND AN OPTICAL MODEL OF SCATTERING. Miyazaki, T. (Tokyo Univ. of Education. Tokyo Univ.). Lett. Nuovo Cim.; 2: No. 18, 929-33(30 Oct 1971).

An optical model of scattering is presented, and it is proposed that at high energy elastic scattering of particles should occur according to the classical concepts of random flights and that the form factors should be the damping factors of the probability or the modules of elasticity. (L.B.S.)

3285 EXCITED VERTICES IN THE MODEL OF NEVEU AND SCHWARZ. Rosenzweig, C. (Univ. of Colorado, Boulder. Harvard Univ., Cambridge, Mass.). Lett. Nuovo Cim.; 2: No. 18, 924-8(30 Oct 1971).

It is shown that the new techniques used to understand the spectrum of the conventional Veneziano model are also applicable to models in which new gauges are introduced, using the model of Neveu and Schwarz as an example. Vertices for the excited states of their model are constructed in the operator formalism and the amplitude for scattering of N ρ-mesons is calculated. (L.B.S.)

3286 HADRONIC INTERACTIONS AT SMALL DISTANCES. Migdal, A. A. (Inst of Theoretical Physics, Moscow). Phys. Lett.; 37B: No. 1, 98-100(1 Nov 1971).

Using conformal invariance with the anomalous dimensions of fields, 3-point amplitude of hadronic interactions at small distances is found in a closed form. $\pi^0 \to 2\gamma$ (virtual) decay is forbidden. Form factors decrease by a power law, and estimate of the exponents in a quark model gives q^{-4} for π and q^{-6} for N. (auth)

3287 FAVORED AND DISFAVORED FRAGMENT DISTRIBUTIONS. Chou, T. T. (Univ. of Denver). Phys. Rev. Lett.; 27: No. 18, 1247-9(1 Nov 1971).

The general form of the τ_1 distribution function for favored and disfavored fragmentation is obtained from the fragmentation picture. The $(1-x)^5$ dependence for the τ_1 function is found to be in very good agreement with existing experimental data. (auth)

3288 NONORIENTABLE DUAL LOOP GRAPHS AND ISOSPIN. Shapiro, Joel A. (Univ. of Maryland, College Park). Phys. Rev., D; 4: No. 4, 1249-51(15 Aug 1971).

Internal symmetries of type SU(n) are incorporated via Paton–Chan factors into the dual-resonance model. The higher-order diagrams are then formally constructed. It is shown that nonorientable diagrams do not contribute, and the "Pomeranchon" graph does contribute to $C = -1$ states. (auth)

3289 FURTHER COMMENTS ON THE RELATIONS BETWEEN DUAL MODELS AND CHIRAL SYMMETRY BREAKING. Galli, Alicia; Galli, Eduardo (Univ., Sao Paulo, Brasil). Phys. Rev., D; 4: No. 4, 1253-7(15 Aug 1971).

Certain peculiar aspects present in dual-resonance models (collectively called "algebraic duality") led to the construction of amplitudes coincident with those coming from the nonlinear σ model in the SU(2) case, and from a U(3) $\otimes$ U(3) nonlinear Lagrangian with a breaking which preserved the complete pseudoscalar nonet degeneracy in the more general case. The singlet is split from the octet, breaking algebraic duality in a simple way. (auth)

3290 COMMENTS ON A DUAL MULTIPARTICLE THEORY WITH NONLINEAR TRAJECTORIES. Baker, M. (Univ. of Washington, Seattle); Coon, D. D. Phys. Rev., D; 4: No. 4, 1234-7(15 Aug 1971).

Some features of the nonlinear trajectories of a dual multiparticle theory are examined and the development of the theory is discussed. (auth)

3291 EMBRYONIC DUAL MODEL FOR PIONS AND FERMIONS. Thorn, Charles B. (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 4, 1112-5(15 Aug 1971).
D; 4

A dual-resonance amplitude for N pions and two fermions is presented. In the fermion–antifermion channel the spectrum of mesons and their couplings to N pions are precisely those of the Neveu–Schwarz model. In fermion-meson channels the spectrum is that of Ramond's propagator. Thus there are a sufficient number of gauges to remove all ghosts—fermion and meson. By factorizing in the fermion–antifermion channel the vertex function is extracted for (excited meson) $\to$ (fermion–antifermion pair). (auth)

3292 ELECTROMAGNETIC CURRENTS IN DUAL HADRODYNAMICS. Nambu, Yoichiro (Univ. of Chicago). Phys. Rev., D; 4: No. 4, 1193-1202(15 Aug 1971).

A possible scheme of introducing electromagnetic currents in the dual-resonance model in such a way as to maintain duality in many-photon amplitudes is discussed. It turns out that the currents build up a pair of trajectories (Pomeranchukon-like and photon-like) with intercept one. A more specific ansatz for the current vertex gives generalized ρ-dominance form factors and a scaling behavior of the inelastic structure function νW_2. (auth)

3293 LIGHT-CONE STRUCTURE OF CURRENT COMMUTATORS IN THE GLUON–QUARK MODEL. Gross, David J.; Treiman, S. B. (Princeton Univ., N. J.). Phys. Rev., D; 4: No. 4, 1059-72(15 Aug 1971).

The formal structure of current commutators near the light cone (currents separated by nearly lightlike distances) is studied for quark models with interactions mediated by SU(3) $\times$ SU(3) singlet vector or scalar mesons. The idea in the end is to abstract the general structure features, and thereafter to discard the specifics of the underlying model. The approach adopted here is formal, in the sense that all manipulations are based on canonical equal-time commutation relations and on the corresponding canonical equations of motion. The light-cone commutator is expressed in terms of certain bilocal operators and has a definite tensor and SU(3) $\times$ SU(3) structure that forms the heart of the abstraction. The analysis is greatly facilitated by a theorem which shows that the gluons can be treated in the external-field approximation for purposes of determining the leading light-cone singularities. It is an important result that the tensor and SU(3) $\times$ SU(3) structure of the light-cone commutator turns out to be the same for the gluon models as for the free-quark model. The practical implications of this structure, already discussed by Gell-Mann, are therefore preserved in the gluon model. The applications are reviewed. Some of the delicate points connected with current conservation are discussed, and it is shown how to write the commutator in a form where current conservation is manifest. The structure of the vacuum matrix elements of the commutator is also discussed. Finally, the commutation relations among the bilocal operators are investigated and it is shown that the algebra closes for bilocals defined on a single lightlike ray. In an Appendix various results are compared with those obtained by canonical light-cone quantization procedures. (auth)

3294 VENEZIANO-MODEL PREDICTIONS OF DENSITY MATRICES FOR FINAL VECTOR MESONS. Aurenche, P. (Univ. of Illinois, Urbana). Phys. Rev., D; 4: No. 4, 1039-46 (15 Aug 1971).

The generalized Veneziano model is used to describe the hypothetical reaction $\sigma\sigma \to \rho\rho\sigma$. The amplitude for this process is, in this model, the residue at the double spin-1 resonance of the seven-point function. The density-matrix elements of the vector mesons produced are calculated, and their variation with the momentum transfers is studied. (auth)

3295 OFF-MASS-SHELL EXTENSION OF PHENOMENOLOGICAL FORM FACTORS. Choudhury, D. K. (Oxford Univ.). Lett. Nuovo Cim.; 2: No. 17, 895-8(23 Oct 1971).

It is shown that off-shell crossing symmetry connot be imposed on hadron form factors from the arguments of causality and covariance. (L.B.S.)

3296 FACTORIZATION IN HIGH ENERGY HADRON COLLISIONS. Van Hove, L. (CERN, Geneva). Ann. Phys. (N. Y.); 66: No. 2, 449 56(Aug 1971).

The concept of factorization is discussed for elastic diffraction scattering and diffraction dissociation of hadrons at high energy. In addition to the usual definition in terms of the t-channel, a natural definition of factorization in the s-channel is proposed and compared with the former. It is shown that s-channel factorization of all diffractive processes is consistent with the assumption that elastic scattering is identical to the shadow of the diffraction dissociation processes. (auth)

3297 PARTONS AND THEIR APPLICATIONS AT HIGH ENERGIES. Drell, Sidney D.; Yan, Tung-mow (Stanford Univ., Calif.). Ann. Phys. (N. Y.); 66: No. 2, 578-623(Aug 1971).

Feynman's parton model for deep inelastic weak or electromagnetic processes is discussed as an application of the impulse approximation to elementary particle interactions. The special features and conditions permitting this application are elaborated upon in some detail including the dependence of the parton model and the impulse treatment on an appropriate choice of coordinate

frames and the role of the very soft or "wee" partons. Application of the parton model is made to the calculation of the cross section for massive lepton pair production in very high energy hadron-hadron collisions and compared with experiment. The conjectured role of light cone singularities in describing this and the other deep inelastic amplitudes is also discussed. (auth)

3298 LOCALIZATION OF STRONG INTERACTION AND RANDOM FRAGMENTATION AS A MODEL OF HIGH-ENERGY COLLISIONS. Narayan, D. S. (Tata Inst. of Fundamental Research, Colaba, India). Nucl. Phys.; B34: No. 2, 386-96(1971).

A model of particle production in hadron collisions is presented. The model accounts for the strong damping of $P_\perp$, a weaker damping of c.m. $P_{||}$, survival of the incident baryon, a slow variation in the relative abundance of particle types and a Poisson distribution in the number of charged pion pairs. The calculated multiplicities are in reasonable agreement with experiment. The model predicts a forward-backward asymmetry in π-N collisions and a high inelasticity at super-high energies. (auth)

3299 UNITARITY, FACTORIZATION THEOREM, AND REMOVAL OF LEVEL DEGENERACY IN DUAL RESONANCE MODEL. Kawati, Syozi (Kwansei Gakuin Univ., Nishinomiya, Japan); Konisi, Gaku; Saito, Takesi; Tanaka, Azuma. Progr. Theor. Phys. (Kyoto); 46: No. 2, 609-13(Aug 1971).

It is shown that, by using a unitarity relation for a many-body scattering amplitude, a Regge residue appearing in this amplitude is factorized. This theorem is a generalization of that in the two-body case. According to this theorem the famous level degeneracy in dual resonance models is expected to be removed, if unitarity is taken into account. An equation is proposed for removing the degeneracy, which has a close resemblance to that in the quantum mechanical perturbation theory with degenerate levels. (auth)

3300 DUAL-RESONANCE AMPLITUDE AS A GENERALIZATION OF FEYNMAN'S PROPAGATOR. Minami, Masatsugu (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 2, 614-33 (Aug 1971).

With the aid of the dual four-position fields, the Veneziano amplitude is shown to have a functional integral representation whose prototype is found as the conventional Feynman propagator. The method of dual positions leads to the boundary-value problem of Dirichlet's type and enables the Koba-Nielsen kernel to be easily decomposed in correspondence with a factorization of the corresponding physical process. (auth)

3301 HIGH ENERGY ELASTIC HADRON–HADRON SCATTERING AND ELECTROMAGNETIC STRUCTURE OF HADRON. Kitani, Kohei; Nagatsuka, Yoshitaka; Yoshii, Hiroaki (Tokyo Inst. of Tech.). Progr. Theor. Phys. (Kyoto); 46: No. 2, 505-16(Aug 1971).

The differential cross section for hadron-hadron elastic scattering at high energy and the electromagnetic form factor of hadron are studied in the framework of the parton model. The electromagnetic structure function, νW_2^{1H}, for deep inelastic lepton-hadron scattering is calculated and the Drell-Yan conjecture is used to relate it with the electromagnetic form factor of meson (baryon) which is shown to decrease as $(-t)^{-\frac{1}{2}}((-t)^2)$ for large $(-t)$. Assuming the universal four-Fermi interaction for partons, the Wu-Yang conjecture is extended so that the differential cross sections for elastic meson-baryon and baryon-baryon scatterings for large $(-t)$ decrease as $(-t)^{-7}$ and $(-t)^{-8}$, respectively. (auth)

3302 ABSORPTION STRUCTURE IN EIKONAL DROPLET SCATTERING. Koyama, Hideyuki (Univ. of Osaka Perfecture, Sakai, Japan). Progr. Theor. Phys. (Kyoto); 46: No. 2, 517-26 (Aug 1971).

A droplet model proposed by Chou and Yang is further studied on the basis of the Glauber theory. For the purpose of deriving constant absorption in droplet (hadron) scattering at high-energy limit, an independent fermion-antifermion pair model within a c-number theory is proposed. A constituent particle of a hadron in the Chou-Yang picture is identified with the pair called "dion". Under the assumption that the pair is in a spin singlet and S-wave state and that a fundamental potential is a current × current with chiral symmetry, it is shown that the pair behaves like a dipole and hadron-hadron scattering amplitude becomes imaginary constant in a high-energy limit. Scatterings among baryon, antibaryon and meson are derived in a unified way with a few parameters which characterize the inner structure of hadron. (auth)

3303 MULTI-LOOP SELF-ENERGY OPERATORS IN THE DUAL RESONANCE MODEL. Sakai, Sunao (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 2, 590-608(Aug 1971).

Four kinds of primitive self-energy operators are constructed by making use of Feynman-like rules established by factorizing the n-point Veneziano amplitudes. A reduction formula for obtaining the multi-loop self-energy operators is also derived. Singularities of a new type which are absent in the n-loop self-energy operators appear when the (n + 1)-loop self-energy operators are constructed. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 3101, 3133, 3384, 3386, 3387, and 3436.

3304 (INP–763, pp 23-33) MANY BODY DECAYS OF RESONANCES AND STATISTICAL TENSORS. Kotanski, A. (Jagellonian Univ., Krakow (Poland). Inst. of Physics); Zalewski, K. (Institute of Nuclear Physics, Krakow (Poland)). 1971.

In Proceedings of the XI Cracow School of Theoretical Physics. Volume II.

The formalism of statistical tensors is used for many-body decays of resonances. Moments of the decay distribution and coefficients are discussed. Examples for the decays $1^+ \to 0^- + 0^- + 0^-$, $1^- \to 0^- + 0^- + 0^-$, $2^+ \to 0^- + 0^- + 0^-$, $2^- \to 0^- + 0^- + 0^-$, $\frac{1}{2}^- \to \frac{1}{2}^+ + 0^- + 0^-$, $\frac{1}{2}^+ \to \frac{1}{2}^+ + 0^- + 0^-$, $\frac{3}{2}^+ \to \frac{1}{2}^+ + 0^- + 0^-$, and $\frac{3}{2}^- \to \frac{1}{2}^+ + 0^- + 0^-$ are given. (J.F.P.)

3305 DYNAMICAL QUARK MODEL OF MESONS. Kajzar, F.; Rayski, J. (Jagellonian Univ., Krakow). Acta Phys. Pol.; B2: No. 5, 575-81(Sep-Oct 1971).

A dynamical quark model of mesons based on the principle of a temperate interaction enabling the application of the Tamm–Dancoff method combined with a suitable cut-off is presented. The main result is that it is not at all necessary to assume an unreasonably high value of the coupling constant in order to obtain a very large mass defect of the bound quark-antiquark system. (auth)

3306 MOVING CDD POLES AND COMPLEX REGGE TRAJECTORIES. Antoniou, N. G.; Baier, R. (CERN, Geneva). Nuovo Cim.; 5A: No. 3, 392-406(1 Oct 1971).

A mechanism for generating dynamical fixed cuts in the angular-momentum plane, based on moving CDD poles, is proposed. In particular, the splitting of Regge poles coupled to the $\pi\pi$ system is studied. Implications on low-energy scattering and on high-energy phenomenology are discussed. (auth)

3307 THEOREMS ON POMERON COUPLING. Arafune, J. (Tokyo Univ.); Sugawara, H.; Hara, Y. Phys. Lett.; 37B: No. 1, 92-4(1 Nov 1971).

It is shown that (1) the tri-Regge amplitude where one of the Regge poles is the Pomeron (at t = 0) cannot have the expected tri-Regge behavior and (2) the single particle distribution function has the following form: $k_0 d^3\sigma/dk_\perp^2 dk_{||} = (1 - x)f(k_\perp^2 + k_{||}^2) + g(k_\perp^2 + k_{||}^2)$ where $x = (k_0 - k)/m$ and $k_\perp$ and $k_{||}$ are the transverse and longitudinal laboratory momentum of the produced particle, respectively, and m is the mass of the target. (auth)

3308 ELECTROMAGNETIC INTERACTIONS OF MASSIVE GAUGE FIELDS. Finkelstein, Robert J.; Kvitky, Joel S. (Univ. of California, Los Angeles). Ann. Phys. (N. Y.); 65: No. 1-2, 361-85(15 Jun 1971).

The electromagnetic interactions of the vector mesons are discussed in terms of the Lagrangian of a massive gauge field. It has been shown elsewhere that this Lagrangian makes some successful correlations between the strong interactions at low energies and the weak currents. If the electromagnetic field is introduced in a minimal way, the resulting Lagrangian also provides a possible description of the electromagnetic properties of the hadrons as well as the leptons. In this scheme the pseudoscalar mesons are coupled to the electromagnetic field only through the massive vector particles. The differences in electromagnetic structure between the proposed theory, which has SU(3) symmetry, and a corresponding SU(2) model are investigated; and in particular, it is shown in the SU(3) case that the source of the electromagnetic field is determined not only in the usual way by the convective current and the magnetic moment of the charged mesons, but alternatively and equally well by the neutral mesons in accordance with the field current identities. The corresponding SU(2) model does not have this feature. Finally, it is suggested that the theory is more convergent than an arbitrary charged vector theory because of its chiral SU(3) structure. (auth)

3309 EXCITED STATES OF MESONS AND THE QUARK–ANTIQUARK INTERACTION. Smith, G. B.; Tassie, L. J. (Australian National Univ., Canberra). Ann. Phys. (N. Y.); 65: No. 1-2, 352-60(15 Jun 1971).

The Dirac equation is used in an investigation of the properties of mesons according to the quark-antiquark model. The dependence of the meson mass on angular momentum excitation is considered for several models. The properties of the Dirac equation with a potential consisting of an equal mixture of scalar and vector potential are investigated. (auth)

3310 DISPERSIVE APPROXIMATIONS FOR $\pi\pi$ PARTIAL WAVES WITH ESSENTIAL SINGULARITIES. Tryon, E. P. (Columbia Univ., New York). Phys. Rev., D; 4: No. 4, 1221-5(15 Aug 1971).

It is shown that despite the apparent essential singularities in Veneziano $\pi\pi$ partial waves with I = 0 and I = 2, these partial waves can be approximated to any desired accuracy over a substantial region about threshold by functions which do satisfy dispersion relations of the usual form, although the number of subtractions required increases without limit as the desired accuracy tends toward exactness. Two subtractions are shown to be sufficient to approximate the S waves within 10% up to $E_{c.m.}$ = 700 MeV. A dispersive method is proposed for unitarizing the Veneziano amplitudes up to 1 GeV or more. (auth)

3311 CROSSING-SYMMETRY RESTRICTION ON DISPERSION RELATIONS, AND SUM RULES FOR $\pi\pi$ SCATTERING LENGTHS. Krinsky, Samuel (Yale Univ., New Haven). Phys. Rev., D; 4: No. 4, 1046-52(15 Aug 1971).

The constraints crossing symmetry imposes on fixed-variable dispersion relations for $\pi\pi$ scattering are studied. It is shown that the sum rules relating $2a_0^0 - 5a_0^2 - 18a_1^1$, a_2^0, and a_2^2 to the total cross sections, which were derived by Wanders using the Mandelstam representation, follow from twice-subtracted dispersion relations. These sum rules are good physical-region constraints to supplement the unphysical-region constraints of Martin and Roskies in the study of models for low-energy $\pi\pi$ scattering. Using a restriction on the absorptive parts following from crossing symmetry, Wanders's sum rule for the I = 0, I = 2 scattering length is transformed into a form which is manifestly positive. Keeping only the S- and P-wave contributions, a lower bound is obtained for a_2^0. If the ρ-trajectory intercept is less than 1, it is shown that $\lim_{s\to\infty} \mathrm{Re}\, T^I(s, 0, 4-s)/s$ is determined by the total cross sections. If, in addition, the leading isospin-2 trajectory has intercept less than zero, then even without imposing elastic unitarity, the I = 0 S wave is determined by the absorptive parts without the freedom of adding an arbitrary constant. (auth)

3312 QUARK MODEL OF DUAL PIONS. Neveu, A.; Schwarz, John H. (Princeton Univ., N. J.). Phys. Rev., D; 4: No. 4, 1109-11(15 Aug 1971).

Interacting pseudoscalar pions are incorporated into Ramond's model of free dual fermions. By considering the emission of N − 1 pions and factorizing in the quark–antiquark channel, the same N-pion amplitudes are recovered as were proposed in a previous paper. (auth)

3313 INTERNAL SYMMETRY PROPAGATION IN THE STRONG-INTERACTION S MATRIX. Cushing, James T. (Univ. of Notre Dame, Ind.). Phys. Rev., D; 4: No. 4, 1177-84(15 Aug 1971).

A strong-interaction S matrix is considered in which the $\pi\pi$ system has the lowest threshold, and the $K\bar{K}$ system the next threshold (i.e., only two-body states are allowed up to and slightly beyond the $K\bar{K}$ threshold). It is shown that if the $\pi\pi$ scattering amplitudes below the $K\bar{K}$ threshold are isospin-invariant, then unitarity, crossing symmetry, and sufficient analyticity demand isotopic spin as the least trivial symmetry of the $K\bar{K} \to K\bar{K}$, $K\bar{K} \to K\bar{K}$, and $K\pi \to K\pi$ amplitudes. In every case, all of the isospin relations are obtained. It is also pointed out that an assumption that various partial waves are correlated can be used to replace the assumption that the S matrix can be diagonalized by a constant matrix. (auth)

3314 INVERSE-AMPLITUDE (K-MATRIX) METHOD FOR UNITARIZING VENEZIANO AMPLITUDES, WITH APPLICATION TO $\pi\pi$ SCATTERING. Tryon, E. P. (Columbia Univ., New York). Phys. Rev., D; 4: No. 4, 1202-15(15 Aug 1971).

The so-called K-matrix method for unitarizing Veneziano amplitudes is analyzed and shown to consist of proposing models for the differences between inverses of physical partial-wave amplitudes and the inverses of Veneziano partial-wave amplitudes. A precise formulation of the method is given, and a detailed analysis is made of the implications of analyticity, elastic and inelastic unitarity, crossing symmetry, Pomeranchukon exchange, and Regge asymptotic behavior. The difficulty of avoiding ghosts within such a framework is discussed, and the positions and residues of several ghosts present in a unitary model proposed earlier by Lovelace are given. It is argued that ghosts are likely to be present in a substantial number of the models for hadronic scattering amplitudes which exist in the literature. Following a detailed discussion of the aforementioned topics, a set of equations are proposed for inverse partial-wave amplitudes whose solutions may afford an accurate description of $\pi\pi$ elastic scattering for center-of-mass energies up to 1 GeV or more. A numerical procedure for obtaining approximate solutions to the equations is proposed, but the actual computation of solutions is deferred to a later work. (auth)

3315 ASYMPTOTIC BEHAVIOR AND COMPLEX ZEROS OF VENEZIANO AND PHYSICAL $\pi\pi$ PARTIAL WAVES. Tryon, E. P. (Columbia Univ., New York). Phys. Rev., D; 4: No. 4, 1216-20(15 Aug 1971).

It is conjectured for $\pi\pi$ amplitudes with I = 0 and I = 2 that Veneziano partial waves contain essential singularities at infinity, and that both Veneziano and physical partial waves contain infinitely many complex zeros on the physical sheet. (auth)

3316 COMMENT ON CURRENT ALGEBRA BEYOND THE TREE APPROXIMATION. Jen, Chian-li (Brown Univ., Providence). Phys. Rev., D; 4: No. 4, 1246-9(15 Aug 1971).

One of the intermediate steps in the Schnitzer unitarization method for the s-wave $\pi\pi$ scattering amplitudes was improved so as to satisfy the Roskies crossing relations and the Martin inequality relations. His $R(s) = [F(s) - 1]\Delta^{-1}(s)$ to $R(s) - iC(s)\theta(-s) = [F(s) - 1]\Delta^{-1}(s)$ is modified so that some contribution from a nearby left-hand cut can be included. It is found, however, that the phase shifts are essentially the same as those of Schnitzer. (auth)

3317 EFFECTIVE LAGRANGIANS WITH MINIMUM MOMENTUM DEPENDENCE. Castelli, G.; Zerbini, S. (Univ., Bologna). Lett. Nuovo Cim.; 2: No. 16, 817-22(16 Oct 1971).

Two models describing the A_1, ρ, σ, π system are discussed in the framework of chiral effective Lagrangians with the additional restriction of a Lagrangian density containing no more than bilinear couplings. Results are obtained for A_1, ρ, and σ decay widths and $\pi\pi$ scattering lengths in a model with linear realization of the SU(2) × SU(2) group and a model with the limit $m^2 \to \infty$. (L.B.S.)

3318 GROUP-THEORETICAL IMPLICATIONS FOR THE MESON MASS SPECTRUM IN BROKEN CHIRAL SYMMETRIES. Cecchini, C. (Scuola Normale Superiore, Pisa, Italy); Cicogna, G. Nuovo Cim.; 5A: No. 4, 527-43(21 Oct 1971).

In the scheme of chiral symmetries, broken spontaneously and/or explicitly, a Hamiltonian operator is studied containing various symmetry-breaking terms with definite transformation properties under $SU_3 \times SU_3$. The effect of these terms on the mass matrix of the scalar 0± and vector 1± mesons is evaluated, showing that the contributions of terms belonging to the various representations, combined according to a well-defined prescription, essentially of group-theoretical nature, can explain very well the experimental situation. In this way some remarkable mass formulas are obtained, part of which has been obtained in previous literature, by means of other approaches; the procedure, however, shows the group-theoretical content of all these formulas. In particular, the results suggest that a spontaneous breakdown of $SU_3 \times SU_3$ symmetry may occur with a vacuum state, which is almost exactly invariant under the usual SU_3. Some attention is also paid to some Lagrangian models, as a realization of the abstract group-theoretical discussion. (auth)

3319 UNAMBIGUOUS $\pi\pi$ S-WAVES FROM GENERAL PRINCIPLES AND THE EXISTENCE OF THE σ-MESON. Le Guillou, J. C.; Morel, A.; Navelet, H. (CERN, Geneva). Nuovo Cim.; 5A: No. 4, 659-700(21 Oct 1971).

A calculation of S-wave $\pi\pi$ amplitudes is presented based upon known rigorous results due to analyticity, unitarity and crossing symmetry: inequalities and cross sum rules. The experimental P-wave phase shifts between 500 and 1100 MeV are used as an input, and it is shown that the method leads to sharp S-wave phase-shift predictions for a given very-low-energy P-wave amplitude. Uncertainties in the extrapolation of the experimental P-wave phase shifts downwards are mainly responsible for a reasonable dispersion of S-wave phase shifts. Much care is taken in order to introduce correctly long-range forces into the game. The results, in very good agreement with experiment, are physically interpreted, and compared with those of other models, in particular current algebra and field theory calculations. S-wave scattering lengths and zeros are found to be in agreement with current algebra models. A well-defined σ-meson is predicted under the form of a second-sheet pole in I = 0 S-wave amplitude. Its mass, m_σ = 420 MeV, is remarkably independent of any variation of all parameters, in particular of the P-wave scattering length, and it exists even if the phase shift does not pass through 90°. This phase shift is found to be of the "down" type above the ρ mass in the absence of inelasticity. The conclusion is that, if there are no strong I = 2 D-wave forces, the relationship between S and P waves is well determined by analyticity, crossing symmetry and unitarity. (auth)

3320 RIGOROUS CONSTRAINTS ON THE DERIVATIVES OF $\pi\pi$ s-, p- AND d-WAVE AMPLITUDES. Pennington, M. R. (Lon-

don Univ.). Nuovo Cim.; 5A: No. 4, 644-58(21 Oct 1971).

Constraints on the derivatives of $\pi\pi$ s-, p- and d-wave amplitudes below threshold are deduced from crossing, positivity and twice-subtracted dispersion relations. (auth)

3321 TIME CORRELATION PROPERTIES IN CASES OF DEGENERATE DECAY OF STATES. Kobzarev, I. Yu. (Inst. of Experimental and Theoretical Physics, Moscow). Yadern. Fiz.; 13: No. 6, 1333-4(Jun 1971). (In Russian).

The correlation properties of amplitudes were examined which corresponded to a pair of unstable bosons A,B (with spin 0, identical quantum numbers, and general decay scheme). In order to describe the evolution with respect to time, a diagonal state of effective decay in the form of a Hamiltonian was introduced, analogous to that employed in describing K^0 decays. (K.S.W.)

3322 VAN HOVE MODEL OF THE REACTION $\pi^+\pi^- \to \pi^0\pi^0$. Graves-Morris, P. R.; Jenkins, J. D. (Kent Univ., Canterbury, Eng.). Nucl. Phys.; B34: No. 2, 503-8(1971).

An explicit realization of the Van Hove model for the reaction $\pi^+\pi^- \to \pi^0\pi^0$ in the s-channel is constructed with a ρ-meson trajectory exchanged in the $\pi^0\pi^+$ channel. The amplitude has an s-channel normal threshold, and is found to be a generalization of the hypergeometric function. Explicit calculation shows that the small angle differential cross section for $\pi^+\pi^- \to \pi^0\pi^0$ has power law dependence in both s- and t-variables independently. (auth)

3323 CONSTRAINTS AND BOUNDS ON $\pi\pi \to N\bar{N}$ PARTIAL WAVES. Common, A. K. (Kent Univ., Canterbury, Eng); Yndurain, F. J. Nucl. Phys.; B34: No. 2, 509-27(1971).

A number of bounds and constraints are given for the partial-wave amplitudes of the process $\pi\pi \to N\bar{N}$ in the range $0 \le t \le 4\mu^2$ where μ is the pion mass. These relations which are fairly restrictive follow from positivity, analyticity and crossing symmetry and are useful in dispersion relation calculations of the $\pi\pi \to N\bar{N}$ amplitude, and indirectly of the $\pi N \to \pi N$ partial waves. (auth)

3324 TWO TOPICS IN ELEMENTARY PARTICLE PHYSICS: (1) QUARK GRAPHS AND ANGULAR DISTRIBUTIONS IN THE DECAY OF THE AXIAL-VECTOR MESONS. (2) UNIVERSAL CURRENT–CURRENT THEORIES AND THE NONLEPTONIC HYPERON DECAYS. Colglazier, Elmer William Jr. Pasadena, Calif.; California Inst. of Tech. (1971). 133p. University Microfilms Order No. 71-27,094.

Thesis.

Three aspects of the axial-vector mesons are examined: angular distributions of the I = 1 states, mixing of the I = $\frac{1}{2}$ states, and absence of the I = 0 states. Using a model of mesons decaying via production of a quark-antiquark pair with the quantum numbers of the vacuum, the angular distributions in the decays $A_1 \to \rho\pi$ and $B \to \omega\pi$, are related, predicting $2(g_1/g_0)_{A_1} = (g_0/g_1)_B + 1$. This relation is consistent with the present, somewhat ambiguous experimental data. Also, one describes satisfactorily, in terms of two parameters, the partial widths of the 0^+, 1^+, and 2^+ mesons decaying into 1^-0^- and 0^-0^- pairs. The prediction of the model is that $SU(6)_W \times 0(2)_{L_z}$ relations hold among all the D waves and among all the S waves, but not between the two groups. In fact, the two-parameter fit to the data entails a ratio of S-wave to D-wave amplitudes of approximately the same magnitude but opposite sign to that implied by $SU(6)_W \times 0(2)_{L_z}$. Unlike the widths, the angular distributions are sensitive to the relative sign and are thus crucial in determining that the fit of the model differs considerably from the $SU(6)_W$ solution. Parameters of the fit are applied to the 1^+ kaons, which may mix with one another. The results are sensitive to the mixing angle ϕ, and merely assuming lower bounds on widths of both physical states establishes the limits $10° \le \phi \le 35°$. As a result of this mixing, one predicts: the suppression of the $K^*\pi$ mode of the lower peak, the suppression of the ρK mode of the upper peak, and decay distributions in the $K^*\pi$ mode similar to that of the A_1 for the lower state and to that of the B for the higher. The properties of the missing isoscalar mesons are described with particular emphasis on the ninth 1^{++} state. Expected properties of this meson, the D′, include: assignments to a weakly mixed SU(3) singlet, predicted by duality and confirmed by the Gell-Mann-Okubo mass formula; a mass of ~950 MeV, predicted by superconvergence with assumptions about the relative couplings of D and D′; decay modes $\eta\pi\pi$ and $\pi^+\pi^-\gamma$; and the possibility of a suppressed ρ signal in the $\pi^+\pi^-$ spectrum of the $\pi^+\pi^-\gamma$ final state, despite the expectation that the pions are in a state with I = J = 1. These features suggest that a recently reported meson near this mass with decay modes $\eta\pi\pi$ and $\pi^+\pi^-\gamma$ may be a candidate for this state, although $JP^c = 1^{+-}$ is also a definite possibility for the new meson. Because of the limited evidence for the V−A Cabibbo theory in the nonleptonic weak decays, one examines the compatibility with experiment of more general current-current theories. These theories, constrained by universality, are constructed from the neutral and charged currents obtainable in the quark model, i.e., scalar, pseudoscalar, vector, axial-vector, and tensor. Using current algebra and PCAC, a certain class of these theories, including Cabibbo's, is found to be consistent with the S wave amplitudes for the nonleptonic hyperon decays. The P wave amplitudes remain unexplained. Nevertheless, another class of theories, also including V−A, plus the assumption of a symmetric quark model, predict the $\Delta I = \frac{1}{2}$ rule. (Diss. Abstr. Int., B)

3325 USE OF EQUAL-TIME COMMUTATORS INVOLVING THE SYMMETRIC ENERGY–MOMENTUM TENSOR FOR THE DERIVATION OF SUM RULES. Genz, H. (Univ., Karlsruhe, Ger.); Katz, J. Nucl. Phys.; B34: No. 2, 429-44(1971).

The central role that second-order Schwinger terms in equal-time commutators involving the energy density T_{00} play in determining the scaling behavior of local operators is emphasized. Thereby a new derivation is given of the fact that the time component of a conserved current has dimension 3 if it has a dimension at all and if a state $|A\rangle$ exists such that $\langle A|J_0|A\rangle \neq 0$. Assuming that the time component of the non-conserved strangeness changing vector current V_μ^K has a dimension, it is shown by saturation of the matrix element in the infinite momentum frame that the root mean square gravitational factor radii of π and K are the same. In this case, Regge theory is used to justify the infinite momentum limit. The consequences of SU(3) and results for tensor meson dominance are discussed and it is found that a (numerically possible small) subtraction that depends on the SU(3) index M must be present in the pseudoscalar-tensor meson form factor $G_t^M(t)$. The results are in at least approximate agreement with SU(3) for $2^+ \to 0^-0^-$, which allows a value for the width $f \to \bar{K}K$ to be predicted. They also agree with what is known about $f \to \eta\eta$ and $f' \to \eta\eta$. The assumptions include neglect of contributions from the K_A, i.e. the doubtful Q-range 1240−1400 MeV. (auth)

3326 QUARK MODEL FOR HIGH-ENERGY $\bar{p}N \to \bar{B}B$ REACTIONS. Chand, Ramesh (Inst. of Mathematical Sciences, Madras). Progr. Theor. Phys. (Kyoto); 46: No. 2, 492-504(Aug 1971).

In an SU(3) symmetric quark model, the high-energy $\bar{p}N \to \bar{B}B$ reactions are investigated in the crossed t-channel. It is assumed that the physical baryon octet contained in the direct product $3 \otimes 3 \otimes 3$ is given by: 8(physical) = 8′ cos θ + 8 sin θ, where 8 and 8′ arise from $3 \otimes \bar{3}$ and $3 \otimes 6$ respectively. It is found that the available high energy data are in reasonable agreement with our calculations for $\theta \simeq (15-16)°$ and $b \simeq 0.2$; b is the strange-quark-to-nonstrange-quark coupling parameter. Also, independently of the mixing angle θ, a number of sum rules are obtained. (auth)

Strong (Baryon No. = 1)

3327 (DEMO-71/18) PHENOMENOLOGICAL DUAL DESCRIPTION OF THE REACTIONS $K^+p \to K^{*0}\pi^+p$ AND $K^-p \to \bar{K}^{*0}\pi^-p$. Papageorgiou, S. (Democritus Nuclear Research Center, Athens (Greece)). Jul 1971. 25p. Dep. NTIS (U.S. Sales Only).

The reactions $K^+p \to K^{*0}\pi^+p$ and $K^-p \to \bar{K}^{*0}\pi^-p$ are studied with a dual five-point amplitude. An appropriate kinematical factor suitable for six-particle systems is used. The Pomeron exchange contribution is excluded. With the help of the longitudinal phase-space analysis the kinematical domain of the model is defined and a suitable selection of the data is performed. An overall agreement (characteristic of the phenomenological dual vector model) is obtained. (auth)

3328 (FRNC-R-2) NEW POINT OF VIEW IN THE ANALYSIS OF TWO BODY REACTIONS. Barrelet, Etienne (Ecole Polytechnique, Paris (France)). [nd]. 71p. Dep. NTIS (U. S. Sales Only).

An original method for the analysis of two-body reactions, based on the use of the zeros of the scattering amplitude, is presented. (France)

3329 (FRNC-TH-68) EXPLANATION OF THE GOLDHABER EFFECT USING THE MULTIPERIPHERAL MODEL. Hong Tuan, Richard (Paris Univ. (France). Faculte des Sciences). 1969. 86p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The multiperipheral model was tested by comparing predictions of this model with experimental data on the $\pi + p \to 3\pi^+2\pi^-p$ reaction, using in particular the Goldhaber effect as the criterion of validity. An attempt was made to improve on the model by including the possibility of resonance formation. In this respect the reaction $p\bar{p} \to 3\pi^+3\pi^-$ was considered; this reaction is particularly interesting with regard to the very strong $\rho 0$ resonance that it presents. It was assumed that the P wave is dominant

when the pions have a low relative momentum. In this way a fairly satisfactory agreement with experiment was obtained in the cases where there were either one or two $\rho 0$ resonances. Since a satisfactory structure for the high multiplicity production amplitude was not found, a phenomenological and qualitative method was adopted in order to interpret the dynamic Goldhaber effect in terms of the multiperipheral model. (France)

3330 (INP–763, pp 74–95) PHENOMENOLOGICAL ANALYSIS OF THREE-BODY FINAL STATES IN PRODUCTION AND FORMATION. Morgan, David (Rutherford High Energy Lab., Chilton (England)). 1971.
In Proceedings of the XI Cracow School of Theoretical Physics. Volume II.

The review of the analysis of 3π and $2\pi N$ production covers an outline of the method, angular momentum decomposition, the isobar model, charged 3π production at 5 and 7.5 GeV/c, $\pi N \rightarrow 2\pi N$ below 1 GeV, and a note on $p\pi^+\pi^-$ production in 10 GeV/c K^+p interactions. (J.F.P.)

3331 (JINR–P9–5953) SEMICONDUCTOR CONTROL SYSTEM FOR THE 680 MeV JINR SYNCHROCYCLOTRON. Danilov, V. I.; Marchenko, B. M.; Maksimov, Yu. V.; Rozanov, E. I.; Sechenov, M. P.; Smirnov, V. I.; Tomilina, T. N.; Shestov, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

A semiconductor control system is described for synchrocyclotron operation on standard acceleration schedules. A uniform intensity of the expanded beam during the course of 75% of the modulation period was obtained owing to the supply of a sawtooth shaped current to the voltage coils. Control was obtained with the coils assisted by the semiconductor control circuit. (tr-auth)

3332 (NP–19052) EXCHANGE MECHANISMS IN THREE BODY K^+p COLLISIONS. Tuominiemi, Jorma (Helsinki Univ. (Finland). Dept. of Nuclear Physics). 1970. 14p. Dep. NTIS (U. S. Sales Only).

Some three-body $K^+ + p$ interactions mainly at 5 and 8.25 GeV/c are reviewed in terms of different exchange models. Some aspects of the exchange mechanisms are tested in detail. It is found that peripherality is a dominating feature in these reactions and also the strong production of K^* and N^* production. (J.F.P.)

3333 (RLO–2041–59) FEYNMAN-DIAGRAM MODELS OF FERMION REGGE POLE CONSPIRACIES. Robertson, David C. (Oregon Univ., Eugene. Inst. of Theoretical Science). [1970]. 30p. Dep. NTIS.

A Feynman diagram model of spin-J fermion Regge poles is developed for meson–nucleon scattering and is used to study the conspiracies arising from two types of Lorentz invariant couplings. For a completely symmetric coupling, the model automatically leads to a conspiracy relation ($M = \frac{1}{2}$) between two leading trajectories of opposite parity which are MacDowell partners. The second type of coupling, which is antisymmetric in two indices, leads to an $M = \frac{3}{2}$ conspiracy relation between four leading trajectories. At high energies, the $M = \frac{1}{2}$ conspiracy favors the scattering of spin-one mesons with zero helicity in both initial and final states while the $M = \frac{3}{2}$ conspiracy favors mesons of helicity ± 1. Since the $M = \frac{3}{2}$ trajectory chooses nonsense coupling at $J = \frac{1}{2}$, the lowest spin of a particle on the trajectory is $\frac{3}{2}$. (auth)

3334 ROLE OF THE INTERFERENCE TERM IN THE STUDY OF THE $K^-p \rightarrow \Sigma^-\pi^+$ PROCESS. Watal, C.; Agarwal, B. K. (Univ. of Allahabad, India). Lett. Nuovo Cim.; 2: No. 18, 911–14(30 Oct 1971).

An attempt is made to fit the experimental angular distributions for $K^-p \rightarrow \Sigma^-\pi^+$ interactions 440 to 800 MeV/c at nine intervals of ~40 MeV/c by combining a u-channel neutron exchange amplitude with resonance contributions from the direct channel. The interference terms are found to be largely responsible for the reasonable fit obtained. (L.B.S.)

3335 CONNECTION BETWEEN ELASTIC SCATTERING AND DIFFRACTION DISSOCIATION IN A DUAL DIFFRACTIVE MODEL. Counihan, M. J. (Imperial Coll. of Science and Tech., London); Goldsack, S. J.; Otter, G. Phys. Lett.; 37B: No. 1, 81–3(1 Nov 1971).

Using a dual diffractive model to provide an analytic description of the dissociation $K^-p \rightarrow (K^-\pi^+\pi^-)p$, a connection is established with the elastic K^-p scattering. (auth)

3336 FACTORIZATION OF THE DIFFRACTION DISSOCIATION AMPLITUDE IN FOUR-BODY FINAL STATES. Yamdagni, N. K. (Univ. of Stockholm); Ljung, S. Phys. Lett.; 37B: No. 1, 117–20(1 Nov 1971).

The hypothesis of factorization of the diffraction dissociation amplitude was tested by comparing the data from the following two experiments $pp \rightarrow pp\pi^+\pi^-$ (19 GeV/c) and $\pi^-p \rightarrow \pi^-p\pi^+\pi^-$ (16 GeV/c). The technique of longitudinal phase space analysis was used to reveal the diffraction dissociation aspect in highly differential form. The comparison supports the hypothesis for the four-body final states. (auth)

3337 POMERON f^0 PROPORTIONALITY IN INCLUSIVE REACTIONS. Brower, R. C. (CERN, Geneva). Phys. Lett.; 37B: No. 1, 121–4(1 Nov 1971).

The "f^0 dominated" Pomeron, suggested by both multiperipheral and dual models, has strong consequences for inclusive reactions. Combined with exchange degeneracy (for f, ρ, ω, A_2) the $s^{-\frac{1}{2}}$ approach to scaling is controlled by a few constants. As an example, the near constancy of the ratio $d\sigma(K^-p \rightarrow \pi^-X)/d\sigma(K^+p \rightarrow \pi^-X)$ for the proton fragmentation is explained. (auth)

3338 COHERENT PRODUCTION OF PIONS. Horn, D. (CERN, Geneva); Silver, R. Contract AT(11-1)-68. Ann. Phys. (N. Y.); 66: No. 2, 509 41(Aug 1971).

Independent and coherent production of pions in high-energy processes is investigated. A model for coherent production is suggested, and the restrictions due to momentum conservation, charge conservation, and isospin conservation are dealt with in detail. A formalism for the isospin analysis of identical pions is developed and applied to coherent states. Results and consequences are discussed. Experimental examples are compared with the theoretical concepts and ideas. (auth)

3339 INTERPRETATION OF A LARGE VALUE OF THE NUCLEON sigma COMMUTATOR. Olshansky, R. (Brown Univ., Providence). Phys. Rev., D; 4: No. 4, 1244–5(15 Aug 1971).

It is proposed that the value of the nucleon σ commutator σ_{NN} calculated from $\pi-N$ scattering data be used to determine what part of the average baryon mass is due to the chiral-symmetry-breaking interaction. In the $(3,3^*) + (3^*,3)$ model, the large value of σ_{NN} reported by Cheng and Dashen then implies that the baryon mass vanishes in the $SU(3) \times SU(3)$ limit. Study of a Lagrangian model shows that this possibility need not conflict with the Gell-Mann–Oakes–Renner symmetry-breaking Hamiltonian. (auth)

3340 LOCAL MODELS FOR MANY-CHANNEL LOW-ENERGY $\bar{K}N$ SCATTERING. Benayoun, M.; Leruste, P. (College de France, Paris). Nuovo Cim.; 5A: No. 4, 513–26(21 Oct 1971).

A local model—built from the D/D formalism—valid in some neighbourhood of the $\bar{K}N$ threshold is derived. Since the local analysis of the low-energy $\bar{K}N$ scattering involves both zero- and one-total-isospin states, models are proposed for two and three channels. The equivalence which exists between the D/D local model and the one previously developed by Dalitz and Tuan is proved. The conclusions turn out to be of the same kind as those deduced from a previous analysis of the rational models. The conclusions agree with those derived independently by Dalitz through a nonrelated method agree. These conclusions concern the methods used up to now in fitting the experimental data. (auth)

3341 COMPARISON OF THE MULTIPERIPHERAL BOOTSTRAP MODEL OF CHEW–PIGNOTTI WITH EXISTING EXPERIMENTAL DATA. Ganguli, S. N.; Gurtu, A.; Subramanian, A. (Tata Inst. of Fundamental Research, Bombay). Lett. Nuovo Cim.; 2: No. 16, 853–6(16 Oct 1971).

Two aspects of existing data on πp and pp interactions at high energies are compared with predictions from the Chew–Pignotti multiperipheral bootstrap model: (i) the momentum at which the cross section for a reaction consisting of n particles in the final state becomes maximum; and the slopes of matrix elements for reactions at 10 to 30 GeV/c. (L.B.S.)

3342 HELICITY CONSERVATION AS A GHOST-ELIMINATING MECHANISM. Majumdar, R. (Trinity, Coll., Dublin). Lett. Nuovo Cim.; 2: No. 16, 835–8(16 Oct 1971).

It is pointed out that the s-channel helicity conservation in a hadronic process such as $\pi N \rightarrow \pi N$ will automatically lead to a possible physical mechanism for elimination of the so-called ghosts at least for the leading trajectory and perhaps for the other significant even-signatured trajectories as well. (L.B.S.)

3343 BORN TERM SUBTRACTION. A TEST BY INVERSE DISPERSION RELATIONS. Garcia, A. (Centro Atomico, Bariloche, Argentina. Instituto de Fisica Balseiro, Bariloche, Argentina); Violini, G. Lett. Nuovo Cim.; 2: No. 16, 826–8 (16 Oct 1971).

It was previously proposed that Regge expansions are to be written not for the complete amplitudes, but for the amplitudes

stripped of all Born terms in the s and u channels, which have to be added separately. The proposal arose from a phenomenological analysis of πN finite-energy sum rules and continuous-moment sum rules. It is shown that there is a sum rule which provides a test of the proposal, which is essentially independent of the assumptions about the Born terms below the elastic threshold. It is found that such a sum rule provides a strong support in favor of the Born term subtraction. (L.B.S.)

3344 VECTOR CONTRIBUTION TO THE DECAY $\Sigma^- \rightarrow \Lambda + e^- + \bar{\nu}_e$. Mainland, G. B. (Univ. of Texas, Austin). Nuovo Cim.; 5A: No. 4, 597-602(21 Oct 1971).

Recent experimental data indicate that the vector contribution to the decay $\Sigma^- \rightarrow \Lambda + e^- + \bar{\nu}_e$ is not zero. This can be readily explained within the framework of the conserved vector-current hypothesis if isospin mixing between the Σ^0 and Λ occurs in an amount corresponding to a mixing angle $\theta = (0.14 \pm 0.07)$ radians. (auth)

3345 CHARGE- AND HYPERCHARGE-EXCHANGE PROCESSES IN THE VENZIANO MODEL. Maharana, J.; Ramachandran, R. (Indian Inst. of Tech., Kanpur). Nuovo Cim.; 5A: No. 4, 603-18(21 Oct 1971).

Various charge- and hypercharge-exchange processes are studied in the Veneziano model. Differential cross sections were calculated for charge-exchange processes like $\pi^- p \rightarrow \eta n$, $K^- p \rightarrow \bar{K}^0 n$ and $K^+ n \rightarrow K^0 p$, and hypercharge-exchange processes like $K^- n \rightarrow \pi^- \Lambda$ and $K^- p \rightarrow \pi^- \Sigma^+$. Polarization was calculated for certain processes. Fairly good fit was found for the differential cross sections. The results for polarization are in qualitative agreement with experimental results. (auth)

3346 CALCULATION OF THE STATISTICAL WEIGHTS IN $\pi^- p$ INTERACTIONS TAKING INTO ACCOUNT THE SU(3) GROUP. Teleman, Mihaela Compt. Rend., Ser. B; 273: No. 5, 232-5(2 Aug 1971). (In French).

A calculation of the statistical weight for $\pi^- p$ interactions is presented. Interactions with two particles in the final state (a nucleon and a meson) are studied in the framework of the statistical model, with the isotopic invariance replaced by the SU(3) group invariance. (France)

3347 UPPER BOUNDS ON PARTICLE–ANTIPARTICLE ELASTIC CROSS SECTION DIFFERENCES. Roy, S. M. (CERN, Geneva). Nucl. Phys.; B34: No. 2, 528-40(1971).

Assuming isotopic spin invariance, axiomatic upper bounds on the difference between $\pi^- p$ and $\pi^+ p$ integrated unpolarized cross sections are proved and compared with experiment. Similar results for KN scattering are also given. (auth)

3348 σ TERM AND LOW-ENERGY π-N SCATTERING. Altarelli, G. (Univ., Rome); Cabibbo, N.; Maiani, L. Nucl. Phys.; B34: No. 2, 621-31(1971).

A direct expression of the σ term in pion-nucleon scattering is presented in terms of other low-energy parameters. Using listed values for these quantities, $\sigma = (80 \pm 30)$ MeV is obtained.

3349 CONSISTENCY TEST OF THE LOW ENERGY $\bar{K}N$ PARAMETERS USING WEIGHTED DISPERSION RELATION. Kariya, Tadaaki (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto); 46: No. 2, 462-7(Aug 1971).

A consistency test is applied to the parameters of low energy $\bar{K}N$ scattering for isospin I = 0, using a weighted kaon-nucleon forward dispersion relation. It is shown that Kim's multi-channel effective range parameters give less consistent predictions for the NAK coupling constant than the recent constant K-matrix parameters. However, this inconsistency is mainly caused by Kim's P-wave parameters. (auth)

3350 SMOOTHED VENEZIANO MODEL AND πN AND KN TOTAL CROSS SECTIONS AT HIGH ENERGY. Hama, Mitsuru; Kiang, D.; Nakazawa, Kazo (Dalhousie Univ., Nova Scotia). Progr. Theor. Phys. (Kyoto); 46: No. 2, 486-91(Aug 1971).

It is shown that the cuts appearing in the smoothed Veneziano model may not necessarily be connected with the Pomeranchuk singularity. An alternate interpretation is proposed, in which the cuts have the same quantum numbers as the original trajectories being smoothed out. The cuts associated with ρ and ω give a nearly constant contribution to the cross sections at high energy. Applications to the total πN and KN cross sections at high energy are presented. (auth)

3351 ISOSPIN SCATTERING AMPLITUDES AND SERPUKHOV DATA. Saleem, Mohammad; Rafique, Mohammad (Univ. of Punjab, Lahore). Progr. Theor. Phys. (Kyoto); 46: No. 2, 664-5(Aug 1971).

It is shown that if, at asymptotic energies, the assumption that the forward isospin scattering amplitudes are real multiples of each other is combined with the isospin invariance, the results derived agree with the Serpukhov data for $\pi^\pm p$ scattering. (L.B.S.)

3352 BEHAVIOUR OF N-PARTICLE PRODUCTION CROSS SECTION. Myozyo, Yasuo; Noda, Hujio (Kyushu Univ., Fukuoka, Japan). Progr. Theor. Phys. (Kyoto); 46: No. 2, 668-9(Aug 1971).

Recent observations on cross sections for multi-pion production showed that the cross sections σ_N for N-particle production rise steeply from threshold and then decrease at high momenta, and that the position of the maximum can be described by the empirical formula $p_N^{max} = aN^b$, where p_N^{max} denotes the value of the laboratory momentum corresponding to the maximum position of σ_N and a and b are parameters. It is shown that for $\pi^- p$ and pp interactions the experimental behavior of the maximum position of σ_N is determined by the Poisson formula of σ_N and the power dependence of $\langle N \rangle$ and that the universality of b is closely related to the one of the power form of $\langle N \rangle$. (L.B.S.)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 3467, 3537, 3639, and 3643.

3353 (COO-264-585) DEUTERON-STRIPPING REACTIONS AT HIGH ENERGY. Barry, George W. (Chicago Univ., Ill. Enrico Fermi Inst. Chicago Univ., Ill. Dept. of Physics). Sep 1971. Contract AT(11-1)-264. 82p. (EFI-71-43). Dep. NTIS. Thesis.

The bootstrap principle suggests that nuclei (B ≥ 2) should be granted equal status in the nuclear democracy, along with the ordinary (B ≤ 1) hadrons, simply because they interact strongly. Naively, one might expect nuclei to lie on Regge trajectories, and nuclear reactions to be dual, with resonances in the direct channel building up Regge poles in the crossed channel. With these concepts in mind, the simplest deuteron-stripping reactions, viz. $p + p \rightarrow d + \pi^+$, $p + p \rightarrow d + \rho^+$, and $p + d \rightarrow d + p$ are examined in detail. Overall, the most satisfactory model is the one-pion-exchange (OPE) model of Yao. A revised version of the Yao model is presented, and it is demonstrated that it gives a good description of the experimental $pp \rightarrow d\pi$ forward differential cross section from threshold up to the highest energies measured. Furthermore, the model quantitatively accounts for the high-energy behaviors of the $p + p \rightarrow d + \pi^+$ and $p + p \rightarrow d + \rho^+$ forward differential cross sections, which were recently found to have very puzzling high-energy behaviors. Canonical Regge behavior should set in only at much higher energies. The bumps in the resonance region of the $pp \rightarrow d\pi$ cross section do not represent genuine dibaryon resonances, but are merely manifestations of Δ-isobar excitation of one of the nucleons in the deuteron. It is concluded that nuclei do not lie on Regge trajectories, although they do couple to nonexotic trajectories. The OPE mechanism can account for the $pp \rightarrow d\pi$ cross section, even at threshold, where the one-nucleon-exchange contribution is greatly suppressed by the p-d-n vertex form factor. To test the general validity of the OPE model, it is applied to $p + p \rightarrow d + p$ at high energy. The model gives an excellent (one-parameter) fit to the experimental differential cross section over a wide range of energies and backward angles. The excited deuteron model of Kerman and Kisslinger is in principle equivalent to the OPE model. The OPE approximation corresponds to writing for the amplitude an unsubtracted dispersion relation in u, and then assuming that the π-N anomalous cut saturates the dispersion integral. In this approach, the absolute scale of the amplitude is calculable, whereas before it was left as a free parameter. The calculated normalization turns out to be somewhat larger than the experimental value, and to improve on this would require a much deeper understanding of the deuteron structure. Since nuclei apparently lie outside of the hadron bootstrap, the speculation is offered that nuclei may not be hadrons (strongly interacting particles) after all. Their exotic quantum numbers may render them inert to the SU(3)-symmetric strong force, leaving only the SU(3)-breaking medium-strong force through which they can interact. (auth)

3354 (INP-762, pp 183-202) HIGH ENERGY ELON–NUCLEUS COLLISIONS. Goldhaber, A. S. (European Organization for Nuclear Research, Geneva (Switzerland). State Univ. of New York, Stony Brook. Inst. for Theoretical Physics). Jun 1971.

In Proceedings of XI Cracow School of Theoretical Physics. Vol. I.

The nuclear analog of Fraunhofer scattering is discussed in which a wave of some elementary particle, called elon, impinges on a nucleus. Moderately large nuclei are considered. (J.F.P.)

3355 (INR-P-1424) ANALYSIS OF DECAYS OF Λ^7Li. Chlebowska, Daniela (Institute of Nuclear Research, Warsaw (Poland)). 1971. Dep. NTIS (U. S. Sales Only).

The distributions of the p-α and d-α relative energy of the Λ^7Li $\rightarrow$ p + d + α + π^- decay products are calculated with the use of the ϕ (d $-$ α $-$ Λ) cluster wave function of Λ^7Li. For the Λ^7Li $\rightarrow$ ^{3}He + ^{4}He + π^- decay the distributions of the ^{3}He $-$ ^{4}He relative energy and angular distribution of the ^{3}He are calculated with the use of the ϕ (d $-$ α $-$ Λ) and ϕ (^{3}He $-$ t $-$ Λp) cluster wave functions for the description of the Λ^7Li. It is shown that the mentioned angular distribution strongly depends on the structure of the Λ^7Li. The energy distributions for both modes of the Λ^7Li decay agree with the experimental data. (auth)

3356 (JINR-P2-6034) QUASIPOTENTIAL DESCRIPTION OF THE NUCLEON SCATTERING AT SMALL ANGLES AT HIGH ENERGIES. Desimirov, G. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 9p. (In Russian). Dep. NTIS (U. S. Sales Only).

An equation of the quasipotential type is used for describing the scattering at small angles at high energies. The structure of the Born series of successive approximations of the amplitude is studied for the case of the model quasipotential of the Gaussian type. (auth)

3357 (NYO-2262-TA-252) PHENOMENOLOGICAL ANALYSIS OF SINGLE PARTICLE DISTRIBUTION. Shen, Ming-liang (Brown Univ., Providence, R. I. Dept. of Physics). [1971]. 21p. Dep. NTIS.

Data of secondary p_z^*-distribution of different charged prong events with fixed x, those of the same charged prong events with different x, and others in the several ten GeV region are analyzed within the frame work of the "emission model." Quantitative agreements are demonstrated to reaffirm the validity of the model. The implications of the model and the present analysis are discussed. (auth)

3358 (NYO-4032-67) RELATIVISTIC EIKONAL APPROXIMATION AND LOW ENERGY NUCLEON-NUCLEON SCATTERING. Woloshyn, R. M.; Jackson, A. D. (State Univ. of New York, Stony Brook. Dept. of Physics). [1971]. 31p. Dep. NTIS.

The need for proper asymptotic behavior of Born amplitudes defining a nonrelativistic potential is outlined. The relativistic eikonal approximation is reviewed, and a generalized Born amplitude with contributions from crossed ladder diagrams as well as vertex corrections is constructed in the eikonal approximation. The connection between strong and electromagnetic interactions obtained through the eikonal approximation is used to constrain the parameters of nucleon-nucleon scattering. Phase shifts calculated with the generalized Born amplitude as the potential are compared with phase shifts calculated with a one boson exchange potential employing a phenomenological form factor. (auth)

3359 (NYO-4204-22) SCALING FOR HADRONIC FORM FACTORS. Elitzur, Moshe (Rockefeller Univ., New York). [1971]. Contract AT(30-1)-4204. 11p. Dep. NTIS.

Combining the Chou-Yang idea with the scaling property of inelastic electron scattering experiments, a scaling law for the form factors of the hadronic transitions N $\rightarrow$ N* in diffractive scattering is derived. The agreement with experiment is very good. (auth)

3360 NONLOCAL MODEL FOR THE HIGH-ENERGY p-p ELASTIC COLLISION. Camisassa, G.; Moreno, R. (Univ. of Veracruz, Mex.). Rev. Mex. Fis.; 20: No. 2, 129 35(1971).

A calculation of the differential cross section for the p-p elastic collision is made, taking into account the contribution of a scalar, vectorial, or tensorial intermediate meson. The second order of the perturbative approach was calculated using the Feynmann diagrams techniques; the well-known divergence of this series is cutoff supposing that the interaction among hadrons is nonlocal. (auth)

3361 TWO-CHANNEL REACTIONS ON NUCLEI AT HIGH ENERGIES. Darbinyan, S. M.; Koval, L. N. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Fiz.; 6: No. 2, 77-86 (1971). (In Russian).

Two-channel reactions on nuclei at high energies are considered in the Glauber theory framework. (auth)

3362 POMERON AS A REGGE CUT IN NN $\rightarrow$ NN* ($\frac{1}{2}^+$, 1400 MeV). Ahmed, K.; Bari, M. B. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 2: No. 18 919-23(30 Oct 1971).

An attempt is made to arrive at an experimental result on the exchange of the pomeron as a Regge cut in the quasi-elastic reaction NN $\rightarrow$ NN*. The asymptotic behavior of various helicity amplitudes in the presence of a pomeron branch cut in the complex-momentum plane is studied, from which the s-channel spin density matrix for N* on the asymptotic limit is obtained. A corresponding expression for the t-channel density matrix elements is obtained, which may be compared with experimental data. (L.B.S.)

3363 CHIRAL-SYMMETRY BREAKING FROM PION-NUCLEUS LOW-ENERGY SCATTERING. Gensini, P. (Univ., Lecce, Italy). Nuovo Cim.; 6A: 98-106(1 Nov 1971).

The study, via current algebra sum rules, of the systematic dependence of π^--nucleus elastic-scattering lengths on both mass number and isobaric spin can offer a way to discard, on an experimental basis, a (1,8) $\oplus$ (8,1) behavior of the $SU_3 \otimes SU_3$ symmetry-breaking Hamiltonian, together with a further check of the validity of the current algebra approach to low-energy meson processes. (auth)

3364 NEUTRON-PROTON CHARGE-EXCHANGE POLARIZATION. Pal, B. K. (Univ. of California, Berkeley). Nuovo Cim.; 6A: No. 1, 29-37(1 Nov 1971).

The neutron-proton charge-exchange polarization has provided new information to test various theoretical models and exchange degeneracy of ρ and A_2 trajectories. The small polarization which is consistently negative and independent of energy at most points is changing our belief that particles like ρ and A_2 are exchange degenerate. A theoretical model is considered which is capable of reproducing the desired np-pn polarization that has been found experimentally. This model for which the polarization has given reasonable qualitative and quantitative agreement with experimental data is consistent when the polarizations and differential cross sections for the processes np $\rightarrow$ pn and p$\bar{p}$ $\rightarrow$ n$\bar{n}$ are simultaneously studied. (auth)

3365 RESTRICTION ON THE BEHAVIOR OF THE ELASTIC AND INELASTIC CROSS SECTIONS AT HIGH ENERGY. I. Logunov, A. A.; Mestvirishvili, M. A.; Khrustalev, O. A. (High-Energy Physics Inst., Serpukhov, USSR). Teor. Mat. Fiz.; 9: No. 1, 3-43(Oct 1971). (In Russian).

Properties of the cross sections of elastic and inelastic processes following from the general principles of quantum field theory are reviewed. By means of the unitarity and the Dyson representation the analyticity region in the cosθ-plane is established and the lower bound of the forward scattering amplitude decreasing is found. (auth)

3366 AMBIGUITY IN THE NUCLEON-NUCLEON PHASE PARAMETERS NEAR 330 MeV. Signell, Peter; Holdeman, Jonas Jr. (Michigan State Univ., East Lansing). Phys. Rev. Lett.; 27: No. 20, 1393-6(15 Nov 1971).

The two-nucleon data in the energy range 290 to 350 MeV are found to contain an additional solution to the one recently reported by MacGregor et al. Potential models are much closer to this additional solution. Experiments are proposed for deciding between the two solutions. (auth)

3367 SIMPLE REGGE-POLE MODEL FOR pp $\rightarrow$ ppω. Griffiths, David; Saperstein, Alvin M.; Schnitzler, Donald T. (Wayne State Univ., Detroit). Nucl. Phys.; B34: No. 2, 397-417(1971).

The process pp $\rightarrow$ ppω is analyzed in terms of the Reggeized Deck model. Diagrams with $\pi-\rho$, $\pi-$B, $\omega-$pom, and p$-$pom exchange are found to be the important contributors. Extensive use is made of experimental data on the two-body processes πN $\rightarrow$ ωN, pp $\rightarrow$ pp, and γp $\rightarrow$ ωp. Vector dominance is used to obtain ωp $\rightarrow$ ωp from γp $\rightarrow$ ωp. The large amount of experimental data, including the prominent peak in the total cross section, is well accounted for. It is pointed out that interference effects cannot be neglected on phase-space arguments alone, and may be important in this process. (auth)

Particle Invariance Principles and Symmetries

General

3368 (IAE-2009) HYPERSPHERICAL FUNCTIONS FOR THREE PARTICLES. Smorodinskii, Ya. A.; Efros, V. D. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 28p. (In Russian) Dep. NTIS (U. S. Sales Only).

In a closed form a complete system of independent hyperspherical functions with given L, M, which form bases of irreducible representations of the three particle permutation group is constructed. (auth)

3369 (INP-762, pp 31-49) MODEL FOR DIFFRACTIVE PRODUCTION OF PARTICLES IN HIGH-ENERGY COLLISIONS. Bialas, A. (Jagellonian Univ., Krakow (Poland). Inst. of Physics. Institute of Nuclear Physics, Krakow (Poland)). Jun 1971.

In Proceedings of XI Cracow School of Theoretical Physics. Vol. I.

The general ideas of a previous diffraction dissociation mechanism are reviewed, and a proposal for a specific realization of the ideas is given. The model described is based on the idea that the interacting particles are considered as virtual fluctuating objects which become real observable states during the collision process. This model explains all essential features of diffractive production and provides important tests especially for diffractive production from nuclei. (J.F.P.)

3370 (LYCEN-7125) ON THE EIGENVALUES OF THE INVARIANT OPERATORS OF THE UNITARY UNIMODULAR GROUP SU(n). Partensky, A. (Lyon Univ. (France). Institut de Physique Nucleaire). May 1971. 16p. Dep. NTIS (U. S. Sales Only).

The eigenvalues of the invariant operators of the SU(n) group, from I_2 to I_6 were obtained by a purely infinitesimal method. It is shown that the general method proposed previously to obtain these operators is valid only for the two first ones (I_2 and I_3). The correct values, up to I_6, are given. (France)

3371 TIME-REVERSAL SYMMETRY VIOLATION AND THE H-THEOREM. Aharony, A. (Tel-Aviv Univ., Israel). Phys. Lett.; 37A: No. 1, 45-6(25 Oct 1971).

Computer experiments with a dilute gas of hard disks with a time reversal noninvariant interaction are described. The effect on the H-function and on the anti-kinetic behavior is discussed. (auth)

3372 NOTE ON QUANTUM-DYNAMICAL SYMMETRIES. De Angelis, G. F.; Vilasi, G. (Centre de Physique Theorique, Marseille). Nuovo Cim.; 6A: No. 1, 38-48(1 Nov 1971).

The problem of finding, for a given quantum system, a compact Lie group of symmetries such that to any energy level there corresponds an irreducible representation of the group is considered. It is concluded that this is not possible except for particular cases, and that, in general, to a given energy level there corresponds a reducible representation of the group. Examples with such a behavior are given. (auth)

3373 CONSEQUENCES OF ANOMALOUS WARD IDENTITIES. Wess, J. (CERN, Geneva. Univ., Karlsruhe, Ger.); Zumino, B. Phys. Lett.; 37B: No. 1, 95-7(1 Nov 1971).

The anomalies of Ward identities are shown to satisfy consistency or integrability relations, which restrict their possible form. For the case of SU(3) × SU(3) it is verified that the anomalies given by Bardeen satisfy the consistency relations. A solution of the anomalous Ward identities is also given which describes concisely all anomalous contributions to low energy theorems. The contributions to strong five pseudoscalar interactions to K_{14}, to one- and two-photon interactions with three pseudoscalars are explicitly exhibited. (auth)

3374 UNITARY GROUP U(m) AS THE SYMMETRY GROUP OF CURVED PHASE SPACE. Heskia, Said (London Univ.); Sofroniou, S. A. J. Math. Phys. (N. Y.); 12: No. 11, 2280-6 (Nov 1971).

By describing U(m) as the symmetry group of a curved phase space, namely, by describing U(m) as the group of holonomy of a Hamiltonian space endowed with a Riemannian metric, it is shown that the Lie algebra of such a group is prior to any explicit Hamiltonian assumption. (auth)

3375 EXPLICIT BASIS FOR THE REDUCTION U(n + m)↓ U(n) × U(m). Mickelsson, Jouko (Inst. of Theoretical Physics, Goteborg). J. Math. Phys. (N. Y.); 12: No. 11, 2378-82(Nov 1971).

Lowering operators are constructed associated with the multiplicity pattern obtained previously for the labeling of the basis vectors in the reduction of an irreducible representation of U(n + m) with respect to U(n) × U(m). Every basis vector can be written as a product of lowering operators acting on the highest-weight vector. (auth)

3376 REPRESENTATION THEORY OF A NEW RELATIVISTIC DYNAMICAL GROUP. Aghassi, J. J.; Roman, P.; Santilli, R. M. (Boston Univ.). Nuovo Cim.; 5A: No. 4, 551-90(21 Oct 1971).

Via the method of induced representations, all irreducible unitary projective representations of the recently introduced new relativistic dynamical group G_5 are deduced and classified. An explicit form of the transformation law is given. The properties of the corresponding infinite-dimensional basis functions are studied. It is shown that in the limiting case of $l = \infty$ (corresponding to $\tilde{G}_5 \to G_5$) the infinite spin-tower representations become reducible and decompose into irreducible representations of the Poincaré group. The reduction of the direct product of two irreducible unitary ray representations of $\tilde{G}_5$ is studied. The Clebsch-Gordan coefficients are computed. Finally, some comments on the physical interpretation of the results are given. (auth)

3377 PTC-NONINVARIANT LAGRANGIANS. Fushchich, V. I. (Inst. of Mathematics, Kiev). Teor. Mat. Fiz.; 9: No. 1, 91-3(Oct 1971). (In Russian).

With the aid of the energy sign and helicity operators the Poincare-noninvariant Lagrangians and the equations of motion are constructed, which are not invariant under the PTC-transformation. (auth)

3378 CONFORMAL INVARIANCE ON THE LIGHT CONE AND CANONICAL DIMENSIONS. Ferrara, S. (CERN, Geneva); Gatto, R.; Grillo, A. F. Nucl. Phys.; B34: No. 2, 349-66(1971).

Covariance under infinitesimal transformations of the spinor group SU(2,2), the covering group of the conformal group, can place significant restrictions on the Wilson's type analysis of operator products on the light cone. For a discussion of the expansion it is relevant to analyze under such transformations the infinite set of local operators providing a basis for the expansion. An infinite ladder of irreducible representations provides such a basis. The existence of a scaling function places relations between the dimensions of tensors, belonging to inequivalent representations, which are all annihilated under K_λ, the generator of infinitesimal special conformal transformations. These relations are not deducible from conformal invariance alone. A theorem is established which fixes the scale dimension of an irreducible symmetric local operator which is, together with its divergence, annihilated by K_λ. The theorem (or some possible extensions of it) may be useful to build up an algebraic scheme satisfying canonical dimensions. Finally, as an example of a mathematical mechanism providing for the required correlation of dimensions, an algebraic scheme based on enlarging the conformal algebra is discussed. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 3240 and 3318.

3379 BROKEN CHIRAL SU(3) x SU(3) SYMMETRY AND THE CABIBBO ANGLE. Dass, T. (Indian Inst. of Tech., Kanpur). Phys. Lett.; 37B: No. 1, 75-7(1 Nov 1971).

The Cabibbo angle is related to some strong and electromagnetic interaction parameters in a field theoretical model with broken chiral SU(3) × SU(3) symmetry. In the limit when the masses of the chiral partners of the Goldstone bosons are infinite, the relation of Gatto, Sartori and Tonin is recovered. (auth)

3380 REMARKS CONCERNING A MODEL OF GELL-MANN ON CP NON-CONSERVATION. Pakvasa, S.; Tuan, S. F. (Univ. of Hawaii, Honolulu). Phys. Lett.; 37B: No. 1, 89-91(1 Nov 1971).

It is shown that Gell-Mann's model of CP violation via co-operative weak-electromagnetic interactions leads to (i) unique prediction of Fitch–Cronin effect in μ-decay and (ii) gross CP effects in near forward neutrino production of $W^{\pm}$ meson. (auth)

3381 EQUAL TIME COMMUTATORS FROM BROKEN CONFORMAL INVARIANCE AND IMPLICATIONS FOR ASYMPTOTIC SUM RULES. Ciccariello, S.; Gatto, R.; Sartori, G.; Tonin, M. (Univ., Padua Istituto Nazionale di Fisica Nucleare, Padua). Ann. Phys. (N. Y.); 65: No. 1-2, 265-323 (15 Jun 1971).

A nonLagrangian field theory model is developed, extending some ideas by Wilson. The theory is based on simultaneously broken conformal invariance and chiral U(3) ⊗ U(3). The local operators of lowest dimension are assumed to be: the chiral current j^a_μ transforming under U(3) ⊗ U(3) as (1, 0, −1)(0, 0, 0)⊕ (0, 0, 0)(1, 0, −1) plus two singlet components; the fields $u^a(x)$ transforming as $(1 + s,s,s)(-s,-s,-1-s) \oplus (-s,-s,-1-s)(1 + s,s,s)$; two fields w^R belonging to $(s',s',s')(-s',-s',-s') \oplus (-s', -s',-s')(s',s',s')$; the traceless part of $\theta_{\mu\nu}$. Furthermore $\theta_{00} - \epsilon^a u^a - \epsilon^A w^A$ commutes with all U(3) ⊗ U(3) generators. In the limit $\epsilon \to 0$ (skeleton theory) one assumes U(3) ⊗ U(3) invariance and conformal invariance, with definite tensor properties of the above operators under conformal transformations. Systematic use of the invariance properties allows for a calculation of all the equal time commutators among the currents, $\theta_{\mu\nu}$, and the densities u^a and w^R in terms of some parameters. Applications of the theory to asymptotic electroproduction and neutrino production sum rules are considered. (auth)

3382 DIVERGENT VERTICES AND ANOMALOUS DIMENSIONS. O'Donnell, P. J.; Wong, T. P. (Univ. of Toronto). Phys. Rev., D; 4: No. 4, 1025-32(15 Aug 1971).

A study of scale-invariance breaking and its connection with anomalous dimensions is presented. A new relation between the anomaly in scale dimension of the pion field and the low-energy form of its gravitational vertex function is obtained, without the use of perturbation theory. (auth)

3383 NONLINEAR REALIZATIONS AND EFFECTIVE LAGRANGIANS FOR CHIRAL SYMMETRY BREAKING. Jones, R. B. (Queen Mary Coll., London). Nucl. Phys.; B34: No. 2, 493-502(1971).

The application of PCAC to pions and kaons transforming nonlinearly under SU(3) × SU(3) is shown to determine uniquely, to all orders in the fields, an effective symmetry breaking Lagrangian for pseudoscalar mesons. This effective Lagrangian yields both octet symmetry breaking and the Gell-Mann, Oakes, Renner Scheme for the pseudoscalar mesons. (auth)

Applications (Strong)

Refer also to abstracts 3289 and 3346.

3384 ASYMPTOTIC SU(3) SYMMETRY, GENERALIZED BOSON NONET COUPLINGS, AND THE NINTH PSEUDOSCALAR MESON. Oneda, S. (Univ. of Maryland, College Park); Matsuda, S. Phys. Lett.; 37B: No. 1, 105-8(1 Nov 1971).

In the framework of asymptotic SU(3) symmetry and the chiral SU(3) ⊗ SU(3) charge algebra, it is shown that nonet boson couplings and mass relations exhibit certain simple patterns. In particular, Schwinger's mass formulas emerge for boson nonets and its implications for the X(958) and E(1422) are discussed. (auth)

3385 SYMMETRY-BREAKING ROLE OF THE κ MESON. McKay, Douglas W. (Univ. of Kansas, Lawrence); Palmer, William F. Phys. Rev., D; 4: No. 4, 1018-25(15 Aug 1971).

The symmetry-breaking role of the κ meson is studied in the context of the (3,3*) + (3*,3) model and its role is compared with that of the pseudoscalar mesons in the hypothesis of partial conservation of axial-vector current. In some dynamical schemes, field-divergence identities derived from the hypothesis of partial conservation of axial-vector current may play a parallel role to those derived from partial conservation of vector current, as is evident in many effective-Lagrangian and "hard-pion" calculations. However, the point of view that the vacuum is approximately SU(3)-symmetric, coupled with Dashen's counting of the order of chiral symmetry breaking, suggests a scheme in which κ plays a dynamically dissimilar role to that of the pion or kaon. This possibility is pursued and it is shown that it is required if one demands that certain alternative definitions of the off-mass-shell amplitude are forced to coincide, at least to lowest order of chiral symmetry breaking. In such a dynamical scheme, the κ cannot at small momentum transfer dominate the vector divergence in the same sense that the pseudoscalars dominate the axial-vector divergence. A κ effect can, however, contribute to matrix elements in a higher order of symmetry breaking, and such a scheme is illustrated in a simple Lagrangian model. (auth)

3386 MASS SPLITTING AMONG MESON OCTETS. Buoncristiani, A. M. (Ohio State Univ., Columbus); DeCelles, P. C. Contract AT(11-1)-427. Nuovo Cim.; 5A: No. 4, 631-43 (21 Oct 1971).

The bootstrap model of resonant pseudoscalar-meson scattering, proposed by Chan, DeCelles and Paton, is extended to discuss the dynamical breaking of SU_3 symmetry. The bootstrap hypothesis is invoked to provide a consistent dynamical theory in which to examine the symmetry breaking. However, some results which are independent of the dynamics, in particular, two mass formulas, are derived, one for an octet of scalar mesons, the other for an octet of vector mesons. These formulas are bilinear in the scalar or vector mass (squared) and the pseudoscalar-meson mass (squared). Finally, the independence of dynamical detail of these formulas prompts the conjecture that they are valid for meson octets with spin-parity $J^P = 1^{(-1)1}$ or $1^{(-1)1+1}$. (auth)

3387 ROTATION INVARIANCE AS A FUNDAMENTAL MESON SYMMETRY. Mac Gregor, M. H. (Univ. of California, Livermore). Lett. Nuovo Cim.; 2: No. 16, 846-52(16 Oct 1971).

Rotational invariance is considered in a model as a fundamental meson symmetry. A basis set for constructing meson and baryon band heads is given. These states are combined together on the mass shell to give the observed meson and kaon rotational bands. (L.B.S.)

3388 PROPERTIES OF THE BREAKING OF HADRONIC INTERNAL SYMMETRY. Michel, Louis (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France); Radicati, Luigi A. Ann. Phys. (N. Y.); 66: No. 2, 758-83(Aug 1971).

The directions of breaking of the hadronic internal symmetry by the electromagnetic, semileptonic – and nonleptonic – weak, and CP violating interactions are characterized by remarkable mathematical properties. These directions correspond to idempotents or nilpotents of an algebra and they are critical, i.e., every invariant function for the symmetry group, e.g., (SU(3) × SU(3)) × (1, P, C, PC) has an extremum on these directions. (auth)

Field Theories

General

Refer also to abstract 3511.

3389 NEW APPROXIMATION METHOD FOR WAVE THEORIES. Persides, S. (Univ. of Texas, Austin). J. Math. Phys. (N. Y.); 12: No. 11, 2355-61(Nov 1971).

The scalar field due to a bounded source and obeying the wave equation is analyzed. As a result of this, a set of rules is derived for solving a class of "wave theories," including electrodynamics and general relativity, by expanding the field in a power series of c^{-1} in null-spherical coordinates. The method is applied for the Maxwell equations to give all the well-known results without the use of Fourier analysis and Bessel functions. (auth)

Quantum Field Theory

Refer also to abstracts 3189, 3220, 3221, and 3300.

3390 (CEA-Bib-199) TACHYONS, Gondrand, Jean-Claude (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jul 1971. 26p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Grenoble, France.

The existence of tachyons, particles with velocities greater than light, would not invalidate the theory of relativity. Hypotheses on their existence have led physicists to consider more deeply the significance of the limiting velocity c and to reconsider the principle of causality. Experiments which began in 1963 will either confirm the existence of these particles or search for reasons why they do not exist. (France)

3391 (COO-264-575) CANONICAL APPROACH TO HIGH ENERGY SCATTERING IN MASSIVE QUANTUM ELECTRODYNAMICS. Chang, Lay-Nam (Chicago Univ., Ill. Enrico Fermi Inst.); Chang, Ngee-Pong (City Coll., New York. Dept. of Physics). Apr 1971. Contract AT(11-1)-264. 33p. (EFI-71-23). Dep. NTIS.

By the canonical Hamiltonian approach to field theory the very high energy limit of massive quantum electrodynamics was studied. A series of canonical transformations is introduced which bring the usual Hamiltonian of a neutral vector meson interaction with a conserved current to the effective Hamiltonian that operates at infinite energy. The result obtained for the S-matrix operator is that it factorizes at very high energies:

$$S = S_0 \, (U^+ T \, (\exp \, (-i \int_{-\infty}^{\infty} dt \, H_S^{(v)})) \, U)$$

where S_0 is the S-matrix for the hard meson "core," given previously

$$S_0 = \exp\left\{-i \, \frac{g^2}{(2\pi)^2} \int d^2k \, \frac{dR^{(k_\perp)} \, dL^{(-k_\perp)}}{k_\perp^2 + \mu^2}\right\}$$

and the second operator describes the contribution to scattering due to pionization effects. U is the dressing operator which clothes the hard meson "core" in a coherent state of virtual soft mesons, and the T-product is obviously the time-evolution operator for soft meson dynamics. (auth)

3392 (ORO-3992-6) UNITARITY PROBLEMS IN INDEFINITE METRIC THEORIES. Sudarshan, E. C. G. (Texas Univ., Austin. Center for Particle Theory). Feb 1970. Contracts AT(30-1)-3399; AT(40-1)-3992. 16p. (UT-26-823-6). Dep. NTIS.

A model is constructed for which the transition amplitude in a sector where a pair of complex conjugate particles are produced can be calculated exactly with relative ease. Since energy conservation is no longer effective in preventing the complex energy particles from being produced they are in fact produced. (J.F.P.)

3393 QUASIRELATIVISTIC EQUATIONS IN QUANTUM MECHANICS. Hanus, W.; Janyszek, H. (Nicholas Copernicus Univ., Torun, Poland). Acta Phys. Pol.; B2: No. 5, 695-700 (Sep-Oct 1971).

Two known methods of deducing from quantum electrodynamics the approximately relativistic quantum-mechanical equations for n charged fermions in an external electromagnetic field were discussed in connection with the problem (not completely solved, as yet) of a consistent quantum-mechanical interpretation of such systems in terms of relativistic particle-observables (in the sense of the "mean" observables of Foldy and Wouthuysen). The important role of a "quasirelativistic" wave equation describing positive as well as negative energy states was stressed. A new form of such an equation was proposed and the idea of a new effective method of

its reduction to the subspace of positive energy states briefly outlined. (auth)

3394 CANONICAL DIMENSIONS FOR THE ELECTROMAGNETIC FIELD AND CURRENT IN QUANTUM ELECTRODYNAMICS. Haberler, P. L. F. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Phys. Lett.; 37B: No. 1, 71-4(1 Nov 1971).

It is suggested that the Gell-Mann Low function vanishes for a fixed (large) value of the unrenormalized coupling constant. (auth)

3395 LOCAL APPROACH TO NONLOCALIZABLE FIELDS. Blomer, R. J.; Constantinescu, F. (Univ., Munich). Nuovo Cim.; 6A: No. 1, 62-78(1 Nov 1971).

The J. G. Taylor approach to nonlocalizable massless relativistic fields as weak limits of localizable (and local) ones is analyzed. As a consequence of a break-down of the sharp local commutativity, acausal effects for nonlocalizable fields appear. Nevertheless, the commutator for the nonlocalizable fields has a strong exponential decrease for spacelike separations. This decrease is determined by the order of growth of the field in momentum space. The nonlocalizable fields, as they are constructed in this paper, satisfy many of the important properties of localizable (and local) fields. (auth)

3396 ELEMENTARY SOLUTIONS OF THE SCHROEDINGER EQUATION FOR SOME TIME-DEPENDENT INTERACTIONS. Pietronero, L. (Univ., Rome); Salusti, E. Lett. Nuovo Cim.; 2: No. 18, 960-4(30 Oct 1971).

A procedure is described for obtaining exact solutions of the time-dependent Schroedinger equation for Hamiltonians which satisfy particular properties. Some physical examples are given. (L.B.S.)

3397 SUMMATION METHOD FOR A CLASS OF SERIES WITH DIVERGENT TERMS. Fogli, G. L.; Pellicoro, M. F.; Villani, M. (Univ., Bari, Italy. Istituto Nazionale di Fisica Nucleare, Bari, Italy). Nuovo Cim., 6A: No. 1, 79-98(1 Nov 1971).

A class of functions F(z) for which a formal expansion in power of z gives a Stieltjes series with divergent moments is considered. It is shown that, introducing a proper cut-off for the moments, such a series can be summed in the framework of the Padé-approximant method, through a connection between the limit on the order of the approximants and the limit on the cut-off. Due to this connection, for which some general rules are given, it is possible to obtain rapidly converging approximations to F(z), starting from the knowledge of the first terms of the formal series. (auth)

3398 COMMUTATION RELATIONS AT NULL INFINITY FOR INTERACTING MASSLESS FIELDS. Klarfeld, Joseph; Komar, Arthur (Yeshiva Univ., New York). Phys. Rev., D; 4: No. 4, 987-94(15 Aug 1971).

A Lorentz-covariant field theory for interacting massless fields is presented with a view toward characterizing the solutions and their commutation relations in terms of prescribed initial data at past null infinity, g^-. The interacting fields decouple naturally on g^-, and by employing a perturbative expansion of the fields in powers of the coupling parameter, one can integrate the equations into finite regions. The fields and their Poisson brackets are determined everywhere in space-time by the incoming modes of the free fields and their commutation relations on g^-. In order that the required limits exist at past null infinity, it is found that conditions must be imposed on the asymptotic initial data in the neighborhood of the singular point I^-. The conditions obtained are closely related to the physical requirement of finite incident flux of energy, momentum, and angular momentum. Although the standard canonical commutation relations for the classical fields are recovered for any two points in space-time with a spacelike separation, there is reason to believe that it may no longer be true for the quantized fields. (auth)

3399 SOME REMARKS ON THE NORMAL ORDERING OF LAGRANGIANS. Din, Allan M. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 4: No. 4, 995-9 (15 Aug 1971).

The properties of normally ordered nonpolynomial perturbations of a harmonic oscillator are studied. It is found that the asymptotic behavior of the normally ordered object is not as bad as anticipated in a traditional approach; rather, it has exactly the same behavior as the unordered perturbation. The same arguments also hold in the general field-theoretic case of nonpolynomial Lagrangians. Furthermore, a class of perturbations are studied which are entire functions for which the correct operation of normal ordering is well defined and equivalent to the traditional approach. The normal-ordering operator can be generalized to the case of several fields and thereby an explicit representation of the time-ordering operator can be obtained. (auth)

3400 FEYNMAN RULES FOR THE YANG–MILLS FIELD: A CANONICAL-QUANTIZATION APPROACH. II. Mohapatra, Rabindra Nath (State Univ. of New York, Stony Brook). Phys. Rev., D; 4: No. 4, 1007-17(15 Aug 1971).

Noncovariant Feynman rules are suggested for the Yang-Mills field in the radiation gauge, to all orders with any number of loops using the methods of canonical quantization. It is shown that even though the interaction Hamiltonian in the radiation gauge has an infinite number of terms, the Feynman rules contain the usual three-vector and four-vector vertices, and a vector-scalar-scalar vertex, along with one propagator for the gauge particle and another propagator for the fictitious scalar particle. The fictitious particle, however, appears only within loops, and the scalar loop has as extra factor (-2) relative to the corresponding vector loop. (auth)

3401 CLUSTER-DECOMPOSITION PROPERTIES OF phi^3-PERTURBATION THEORY AMPLITUDES AT HIGH ENERGY. Campbell, David K.; Chang, Shau-jin (Univ. of Illinois, Urbana). Phys. Rev., D; 4: No. 4, 1151-77(15 Aug 1971).

It is established that a cluster-decomposition technique, similar to that used in statistical mechanics, can be applied to the study of high-energy scattering processes. In particular, the multiperipheral amplitudes in a φ^3 field theory with one space and one time dimension are examined in detail. The cluster decomposition provides (1) a mathematically elegant and physically intuitive way of treating terms nonleading in $(\ln s)^n$; (2) a framework in which the Regge asymptotic behavior of the scattering amplitude emerges naturally; and (3) a direct means of calculating the one-particle and multiparticle spectra in inclusive reactions. In addition, further possible applications of the technique are considered, including its extension to a φ^3 theory with three space and one time dimension. Here a simple criterion, based on the form of the cluster decomposition, is established to determine whether a set of amplitudes leads to a Regge pole or to a more complicated singularity structure. (auth)

3402 CONSTRUCTING CONFORMALLY INVARIANT ACTIONS. Longo, Stephen A. (Univ. of Notre Dame, Ind.). Phys. Rev., D; 4: No. 4, 1184-7(15 Aug 1971).

A method is presented which allows one to make an action conformally invariant by use of an extra scalar field. Scale and conformal derivatives are derived and shown to be the same for a given-rank field. Their structure is the same as that found by Salam, but the method is simpler. (auth)

3403 SCALAR-CONFORMAL DERIVATIVES AND CHIRAL-CONFORMAL LAGRANGIANS. Longo, Stephen A. (Univ. of Notre Dame, Ind.). Phys. Rev., D; 4: No. 4, 1188-93(15 Aug 1971).

A scalar-conformal derivative (SCD) was previously derived. The properties of SCD are investigated, showing that when the kinetic energy is expressed in terms of SCD, the trace of the canonical energy-momentum tensor is soft (zero for conformal Lagrangians). For Lagrangians which are both chirally and conformally invariant, the SCD can be reduced to a simple derivative by using the relation $\chi^2 = \pi^2 + \sigma^2$ when the chiral symmetry is realized linearly. In the nonlinear realization of chiral symmetry, for chirally and conformally invariant Lagrangians, the SCD is in agreement with Isham et al. Also, the breaking of a nonlinearly realized chiral symmetry is discussed. When chiral symmetry is broken, one finds that the mass of the χ field is proportional to the mass of the π field. The proportionality constant is shown to be related to the normalization one chooses for the chiral covariant derivative. (auth)

3404 EIKONAL APPROXIMATION TO THE VERTEX FUNCTION ON THE MASS SHELL. Eichten, E. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 4: No. 4, 1225-33(15 Aug 1971).

The eikonal approximation for graphs representing the exchange of an arbitrary connected amplitude l times in the vertex function is developed for a ϕ^3 theory and quantum electrodynamics when the two external particles are on the mass shell and the momentum transfer is large and spacelike. The simplest case of elementary-particle exchange is calculated. (auth)

3405 DIN'S NORMAL-ORDERING PRESCRIPTION. Fels, Stephen B. (Univ. of California, Los Angeles). Phys. Rev., D; 4: No. 4, 1252-3(15 Aug 1971).

The method of normal ordering proposed by Din is shown to yield lowest-order matrix elements which disagree with those of the original model to which it is applied. (auth)

3406 NECESSARY AND SUFFICIENT CONDITION FOR THE SOFTNESS OF THE TRACE OF THE ENERGY-MOMENTUM TENSOR. Schroer, B. (Univ. of Pittsburgh). Contract AT(30-1)-3829. Lett. Nuovo Cim.; 2: No. 17, 867-72(23 Oct 1971).

The normal-product formalism is used to obtain the necessary and sufficient conditions for the softness of the trace of the energy-momentum tensor. The energy-momentum tensor leads to asymptotic scale invariance. (L.B.S.)

3407 OPERATOR ALGEBRAS AND AXIOMS OF MEASUREMENTS. Chen, Etang (East Carolina Univ., Greenville, N. C.). J. Math. Phys. (N. Y.); 12: No. 11, 2364-71(Nov 1971).

The axioms of measurements introduced by Ludwig are formulated and studied in the framework of operator algebras. It is shown that a concrete C*-algebra with identity satisfies the axiom of sensitivity increase of effects if and only if it is a von Neumann algebra; although a von Neumann algebra satisfies the axiom of decomposability of ensembles, however, the axiom of components of the mixtures of two ensembles is true only if a von Neumann algebra is a factor of type $I_n (n < +\infty)$. It is also verified that the set of decision effects, which is proved to be a subset of projections of a von Neumann algebra, has similar lattice structure of quantum mechanics, and its connection with quantum logic in the sense of Varadarjan is also figured out. (auth)

3408 NOTE ON CORRELATIONS. d'Espagnat, B. (Laboratoire de Physique Theorique et Particules Elementaires, Orsay, France). Lett. Nuovo Cim.; 2: No. 16, 823-5(16 Oct 1971).

Correlations between two systems that have once interacted are considered. (L.B.S.)

3409 INTERACTION HAMILTONIAN IN QUANTUM FIELD THEORY. Pavlov, V. P.; Tavluev, G. A. (Mathematics Inst., Moscow). Teor. Mat. Fiz.; 9: No. 1, 80-5(Oct 1971). (In Russian).

The method is described for constructing the interaction Hamiltonian in the interaction representation, which leads to the finite unitary S-matrix in Dyson's form. (auth)

3410 GENERALIZATIONS OF DUAL MODELS. Gervais, J.-L. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France); Sakita, B. Nucl. Phys.; B34: No. 2, 477-92 (1971).

Generalizations of the dual model are discussed in the context of functional integral formulation of the theory. It is noticed that all the symmetries of dual amplitudes are led from the symmetries of the Lagrangian used for the measure of functional integration. Irreducible fields under conformal transformations are classified by their dimension and conformal spin. Since the factorizability of dual amplitudes requires a local Lagrangian, the general form of local Lagrangian density is constructed such that the action integral is conformal invariant. It is found that if one restricts the form of the Lagrangian to bilinear form of the fields, the kinetic term of the Lagrangian is possible to construct only for conformal spin 0 and $\frac{1}{2}$ field. The former yields the usual dual model, while the latter yields the Bardakci–Halpern model and the Neveu–Schwarz one. Quantization of conformal spin-$\frac{1}{2}$ field is discussed in detail. The generating functional of this field is constructed in terms of the functional integral technique and used to construct the general N-particle amplitudes. (auth)

3411 SUM RULES FOR THE MATRIX ELEMENTS CORRESPONDING TO THE SCALAR THREE-POINT FUNCTION. Bohman, Jan (Univ. of Lund, Sweden). Nucl. Phys.; B34: No. 2, 541-56(1971).

Relations for the on-mass-shell matrix elements of locally commuting field operators are derived from the sum rules for the vertex function given by Andersson. The calculation is performed in coordinate space using explicitly the generalized function $\Delta_3^{(+)}$. (auth)

3412 DUAL N-REGGEON VERTEX IN THE FIELD OPERATOR FORMALISM. Kosterlitz, J. M. (Univ. of Birmingham, Eng.); Saito, S. Nucl. Phys.; B34: No. 2, 557-66(1971).

A compact form for the N-Reggeon vertex is derived in the field operator formalism of Fubini and Veneziano and it is shown that it factorizes into three-Reggeon vertices. (auth)

3413 HNZ CONSTRUCTION AND THE Z = 0 CONDITION FOR COMPOSITENESS. Tirapegui, E. (Princeton Univ., N. J.). Nucl. Phys.; B34: No. 2, 598-620(1971).

It is proved that the Z = 0 condition relates two theories with a different number of basic fields in such a way that the vacuum expectation values of T-products of fields are the same on-shell and off-shell in both theories, with the possible exception of the two-point function of the composite particle for which an HNZ local field is constructed in one of the theories. The connection to the Bethe-Salpeter method is also discussed together with other problems related to the Z = 0 condition. (auth)

3414 FIELD THEORY INTERPRETATION OF SUPER-GAUGES IN DUAL MODELS. Gervais, J. -L. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France); Sakita, B. Nucl. Phys.; B34: No. 2, 632-9(1971).

Possible new invariances of generalized dual models are discussed in the context of the functional integral formulation. The operators relevant to new gages of those models, such as those obtained by Neveu and Schwarz, are derived as infinitesimal generators of new field transformations which leave the action integral invariant. (auth)

3415 QUANTUM THEORY OF THE NON-LINEAR REALIZATION OF A GROUP ON ITS SUB-GROUP. Okabayashi, Takao (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 2, 634-58 (Aug 1971).

A quantum theory of the non-linear realization is proposed for the groups with a sub-group which can be realized non-linearly by a single self-conjugate preferred field. In the non-linear realization of a group on its sub-group, the displacement operators in Minkowski space can be written down at once as a sum of two terms. Not only the coefficients of the two terms but also the equal-time commutation relations between field operators and the equation of motion can be determined by the property of the displacement operators. Furthermore, all of them can be proved to be covariant under the internal group. Thus a quantum theory of the non-linear realization can be constructed in a closed form without referring to the Lagrangian formalism or the variation method, where it is difficult to maintain the order of the operators correctly throughout all steps of manipulations. But it is argued that the Fock space cannot be spanned without violating the symmetry. The method can be applied to any non-linear system once the energy-momentum tensor is specified. The difference between non-linear systems and linear ones and that between the Lagrangian formalism and ours are also discussed. (auth)

3416 GREEN FUNCTIONS OF THE DIRAC EQUATION IN THE DE SITTER UNIVERSE. Cahen, M.; Gebeniau, J.; Guenther, M.; Schomblond, C. (Univ., Brussels). Ann. Inst. Henri Poincare, Sect. A; 14: No. 4, 325-33(1971). (In French).

Simple closed expressions for the Green functions of Dirac equations in de Sitter space were obtained. They were deduced from the following property of this space: it is symmetric and conformal Minkowskian with a conformal factor depending only on the distance from one point which is chosen as the origin of coordinates. (France)

Gravitation and General Relativity

Refer also to abstract 3227.

3417 (IFVE-SEF-70-108) QUADRATIC LAGRANGIANS IN GENERAL RELATIVITY. Folomeshkin, V. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

The solutions of the general relativity equations with quadratic Lagrangians $R_{iklm}R^{iklm}$, $R_{ik}R^{ik}$, R^2 are studied. It is shown that nontrivial Euclidian (at $r \to \infty$) solution of the theory equations does not exist when $T \neq 0$ (T is a trace of the energy-momentum tensor of matter). The Schwarzschild solution is not an external part of a total solution when $T \neq 0$. Under condition $T = R = 0$ Lagrangians $R_{iklm}R^{iklm}$, $R_{ik}R^{ik}$ lead to the identical field equations, so there exists the only quadratic Lagrangian and the only field equations. This equation has a solution with an external part being a standard Schwarzschild solution for the static spherically symmetric case. (auth)

3418 (ITF-71-48-P) APPLICATION OF THE ARNOWITT–DESER–MISNER CANONICAL FORMALISM TO THE PERES EXACT WAVE SOLUTIONS. Vlasov, Yu. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 6p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that the total energy and momentum of a gravitational wave packet whose metric is some exact Peres solution of gravitation equations are equal to zero in the ADM canonical formalism. Possible physical interference of the singularities of such exact solutions is discussed. (auth)

3419 CYLINDRICAL SYMMETRY IN EINSTEIN'S UNIFIED FIELD THEORY. I. Klotz, A. H.; Russell, G. K. (Univ. of Sydney). Acta Phys. Pol.; B2: No. 5, 623-36(Sep-Oct 1971).

The static, cylindrically symmetric solutions of Einstein's unified field equations are derived, in the case when only an electric field is present. It is shown that, in general, the strong field equations lead to untenable physical conclusions. (auth)

3420 CYLINDRICAL SYMMETRY IN EINSTEIN'S UNIFIED FIELD THEORY. II. Klotz, A. H.; Russell, G. K. (Univ. of Sydney). Acta Phys. Pol.; B2: No. 5, 637-43(Sep-Oct 1971).

A solution of Einstein's unified field equations corresponding to a static, uniform line charge is derived. It is shown that in the particular case considered the strong and the weak field equations coincide. A possible empirical test of the theory is discussed. (auth)

3421 ENERGY-MOMENTUM COMPLEX OF THE GRAVITATIONAL FIELD. Tran Hu'u Phat (Univ. of Hanoi, North Viet-Nam). Acta Phys. Pol.; B2: No. 5, 567-74(Sep-Oct 1971).

By considering the Riemann space of the general relativity theory as a space imbedded in a pseudo-Euclidean space $E_{10}(1,9)$, a new formalism may be constructed which allows one to solve satisfactorily the energy-momentum complex problem of the general relativity theory and other interesting problems. (auth)

3422 GENERAL-RELATIVISTIC OBSERVABLES VIA HAMILTON-JACOBI FUNCTIONALS. Komar, Arthur (Yeshiva Univ., New York). Phys. Rev., D; 4: No. 4, 923-7(15 Aug 1971).

By means of a canonical transformation, the Hamiltonian of general relativity can be made homogeneous in the momenta. Solutions of the corresponding Hamilton-Jacobi equations yield functionals of the configuration-space variables which are constant over equivalence classes generated by the constraints. The constancy of such solutions of the Hamilton-Jacobi equations is also a sufficient condition for infinitesimally neighboring sets of configuration variables to lie within the same four-dimensional space-time of the given family of Ricciflat manifolds. (auth)

3423 NEW GENERAL-RELATIVISTIC THIN-SANDWICH THEOREM. Komar, Arthur (Yeshiva Univ., New York). Phys. Rev., D; 4: No. 4, 927-30(15 Aug 1971).

Employing a new set of canonical variables for the gravitational field, the configuration variables are assigned on two infinitesimally neighboring spacelike hypersurfaces. It is shown that the problem of determining a solution of the vacuum Einstein field equations consistent with the given data can be reduced to a system of five elliptical differential equations. The determination of the Ricciflat space-time is consequently reduced to a Dirichlet problem requiring data on a two-dimensional surface bounding a three-dimensional spacelike region. (auth)

3424 CANONICAL QUANTIZATION OF CYLINDRICAL GRAVITATIONAL WAVES. Kuchar, Karel (Princeton Univ., N. J.). Phys. Rev., D; 4: No. 4, 955-86(15 Aug 1971).

The Einstein-Rosen cylindrical gravitational waves are quantized by the canonical methods due to Dirac (the constraint formalism) and to Arnowitt, Deser, and Misner (the ADM deparametrized formalism). The general reduction of geometrodynamical phase space to a mini-phase-space by intransitive groups of motion with spacelike Killing vectors is presented. The ADM classical canonical formalism restricted to the infinite-dimensional mini-phase-space generated by the cylindrical group of motions is built up. Six invariantly defined functions of one coordinate label are introduced as new canonical variables by a canonical transformation in mini-phase-space. Two canonical coordinates are identified with the Einstein-Rosen time and cylindrical radius. Canonically conjugate to them are C-energy density and C-energy flux. The third pair of canonical variables carries the ∞^1 dynamical degrees of freedom of the cylindrical wave. The canonical transformation mixes superspace with momentum space, the Einstein-Rosen time being constructed from the extrinsic curvature of the spacelike hypersurface rather than from its intrinsic geometry. The ADM classical canonical formalism for cylindrical gravitational waves is proved to be identical with the parametrized formalism for the cylindrical massless scalar waves propagating in Minkowskian spacetime. The identity of the quantum formalisms follows. The extrinsic time representation, with the Einstein-Rosen time and cylindrical radius as two of the three basic variables, is used instead of the metric representation. The Dirac constraints are imposed on the state functional. If the hypersurfaces are labeled by the Einstein-Rosen cylindrical radius, the constraints are reduced to a functional differential equation of the Schrödinger type. This equation is further reduced to a single partial differential equation by integrability conditions which ensure that the evolution of the state functional between two hypersurfaces is path-independent. The inner product of two state functionals conserved by the deformation of the hypersurface is defined. Under the coordinate conditions restricting the allowable hypersurfaces to those of a constant Einstein-Rosen time, the Dirac formalism is deparametrized into the ADM quantum formalism. (auth)

3425 VACUUM SPACE-TIMES ADMITTING A NULL KILLING BIVECTOR. Debney, George C. Jr. (Virginia Polytechnic Inst. and State Univ., Blacksburg). J. Math. Phys. (N. Y.); 12: No. 11, 2372-7(Nov 1971).

Starting with a vacuum space-time ($R_{ab} = 0$) which admits a Killing vector field K, a study is made of the subclass where the Killing bivector (KBV) $K_{a;b}$ is null. Reference is made to earlier work which established some of the general approach and formalism used. All space-times with the property above turn out to be in the class of expansion-free radiation fields, which are necessarily algebraically special. Of these only Petrov types II, D, and N are allowed; furthermore, those of type N are the pp waves. A result obtained from applying this approach is that expansion-free radiation fields are the only vacuum space-times which admit a geodesic Killing vector field; that field is necessarily lightlike. Finally, since the spaces with symmetry studied previously had nonzero expansion, the associated bivector to each of those symmetries must necessarily be nonnull. (auth)

3426 MOTION AND STRUCTURE OF SINGULARITIES IN GENERAL RELATIVITY. II. Newman, Ezra T.; Posadas, Roger (Univ. of Pittsburgh). J. Math. Phys. (N. Y.); 12: No. 11, 2319-27(Nov 1971).

This, the second in a series on the motion and structure of a class of (elementary) singularities, extends the earlier work on "free" singularities to the interaction of these singularities with "background" gravitational and electromagnetic fields. The principle result is an unusual derivation of the Lorentz-Dirac equations of motion for a charged particle. The results do not depend on any ad hoc assumptions nor upon any renormalization but follow uniquely from the Einstein-Maxwell equations applied to the elementary singularities. A concomitant result is the time evolution of the structure of the singularity. (auth)

3427 EXTERIOR-ALGEBRAIC DERIVATION OF EINSTEIN FIELD EQUATIONS EMPLOYING A GENERALIZED BASIS. Ernst, Frederick J. (Illinois Inst. of Tech., Chicago). J. Math. Phys. (N. Y.); 12: No. 11, 2395-7(Nov 1971).

A tetrad vector formulation of Einstein's field equations is developed in which the orthogonality properties of the tetrad are permitted to vary in any prescribed smooth way from one space-time point to another. The components of the Riemann tensor with respect to such a basis are derived by means of exterior calculus. The approach facilitates a simple direct derivation of the Harrison-Ernst equations. (auth)

3428 GRAVITATIONAL INTERACTIONS OF SCALAR PARTICLES. Tourrenc, Philippe (Univ., Paris). Compt. Rend., Ser. B; 273: No. 5, 229-31(2 Aug 1971). (In French).

The scattering matrix is given for two different types of scalar state in the stable vacuum approximation. It is used to study annihilation and scattering mechanisms. (France)

3429 NEW THEORY OF GRAVITATION. Yilmaz, Hueseyin (Perception Tech. Corp., Winchester, Mass.). Phys. Rev. Lett.; 27: No. 20, 1399-1402(15 Nov 1971).

A locally Lorentz-invariant curved-space theory of gravitation where the local field is a massless, spin-2 field φ_μ^ν of Pauli-Fierz type is presented. In this theory $g_{\mu\nu}$ is no longer the gravitational potential itself but reduces to a functional $g_{\mu\nu}(\varphi_\alpha^\beta)$ of φ_μ^ν. Several rigorous and a general iteration solution of this type are exhibited. The static central body problem reduces exactly to the author's 1958 theory in the special case $\varphi_\mu^\nu \to \varphi\delta_\mu^\nu = \varphi$ and $\partial^\mu\varphi_\mu^\nu \to \partial^0\varphi = 0$ so that as in that theory the three crucial tests are satisfied. (auth)

3430 QUANTUM CONDITIONS IN THE COMPLEX WEYL SPACE. Cherry, N. H. Lett. Nuovo Cim.; 2: No. 15, 794-8(9 Oct 1971).

The quantum conditions of the complex Weyl space are used to find an expression for the energy for the motion of an electron in the presence of a Coulomb field in hydrogenlike atoms. (J.F.P.)

Scattering Theory

Refer also to abstracts 3284, 3306, 3314, and 3328.

3431 (INP-763, pp 34-54) REGGE-CUT MODEL INCORPORATING S-U CROSSING AND DUALITY. Kwiecinski, J. (Institute of Nuclear Physics, Krakow (Poland)). 1971.

In Proceedings of the XI Cracow School of Theoretical Physics. Volume II.

A model for two-Reggeon cuts incorporating planar duality is discussed. The model takes into account the dual structure for auxiliary particle Reggeon amplitudes. The selection rules for secondary Regge cuts and rules for calculation of the cut contribution with duality constraints taken into account are treated briefly. The secondary Regge cuts in hypercharge-exchange reactions are considered in some detail. (J.F.P.)

3432 (ITF-71-46-P) ON THE PARAMETRIC FUNCTIONS OF NONRENORMALIZED FEYNMAN AMPLITUDE. Kucheriaviy,

V. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 23p. (In Russian). Dep. NTIS (U. S. Sales Only).

A method for finding the parametric functions of the Feynman integral with the use of circuit, path and circuit, path matrices is proposed. Definitions of the above matrices are introduced, and some of their properties are indicated. The parametric functions of the Feynman integral are expressed via these matrices by mean of simple analytical expressions. (auth)

3433 (JINR-P2-5990) WENTZEL-KRAMERS-BRILLOUIN METHOD FOR CALCULATING THE AMPLITUDE OF HIGH-ENERGY SCATTERING BY CONTINUOUS POTENTIALS. Pervushin, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 25p. (In Russian). Dep. NTIS (U. S. Sales Only).

The quasiclassical method of Wentzel-Kramers-Brillouin was used to compute the particle scattering amplitude at continuous potentials. The qualitative description of the quasiclassical interaction is stressed as applied to dynamic and kinematic scattering parameters. Attention is also focussed on the physical interpretation of cited results from the point of view of classical principles. (tr-auth)

3434 VENEZIANO TRANSFORM AND THE HIGH-ENERGY BEHAVIOR OF DUAL-RESONANCE AMPLITUDES. Gordon, D. (National Accelerator Lab., Batavia, Ill.). Nuovo Cim.; 6A: No. 1, 107-20(1 Nov 1971).

The Veneziano beta-function transform technique is generalized to the case in which there are several asymptotic variables. The multiple transform of a dual-tree amplitude is found to be again a dual-tree amplitude apart from a well-defined redefinition of the trajectories. The asymptotic behavior of dual amplitudes is discussed, with particular emphasis on the analytic structure in the complex-angular-momentum-like plane. (auth)

3435 ISOTOPIC SPIN SPLITTING OF TRAJECTORIES IN DUAL MULTIPARTICLE MODELS. Anselm, A. A.; Danilov, G. S.; Dyatlov, I. T. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett.; 37B: No. 1, 84-6(1 Nov 1971).

A dual model is considered with trajectories which depend linearly on the square of the total isotopic spin of the channel. It is shown that in spite of the noncommutativity of the operators of isotopic spin of different channels such a model leads to parent trajectories with normal properties: the absence of exotic states and bootstrap-type factorization. On the daughter level nonfactorizable singularities inevitably appear. Being dependent on the details of the model they are either branch points or nonfactorizable poles. (auth)

3436 S MATRIX DESCRIPTION OF STATE MIXING. PART I. GENERAL FORMALISM, WITH RHO OMEGA MIXING AS AN ILLUSTRATION. Warnock, Robert L. (CERN, Geneva). Ann. Phys. (N. Y.); 65: No. 1-2, 386-417(15 Jun 1971).

The notion of state mixing is formulated in terms of S matrix language alone. The object is to work with quantities which are closely related to experiment, while avoiding the particularities of Hamiltonian theory or field theory. The scheme applies to particles of any spin, it is explicitly unitary, and useful in phenomenology as well as in dynamical S matrix models. Unlike the mass matrix method, it avoids the assumption that the states to be mixed evolve from discrete eigenstates of an unperturbed Hamiltonian. The main ingredient is a perturbation method by which the inverse of the K matrix is related to a corresponding unperturbed matrix. In some cases the latter can be defined directly from physical scattering matrices, without the device of turning off interactions. The method is applied to $\rho-\omega$, $\varphi-\omega$, and $K_0-\bar{K}_0$ mixing. The results amount to more than a simple rephrasing of earlier treatments. The discussion of $\rho-\omega$ mixing illustrates that the physical arguments take quite a different form, and some new aspects of mixing questions are brought out. (auth)

3437 MULTIVARIABLE EXPANSION OF THE SCATTERING AMPLITUDE INVOLVING AN ARBITRARY NUMBER OF SPINLESS PARTICLES; CROSSING SYMMETRY FOR PARTIAL WAVES. Modjtehedzadeh, M. (Syracuse Univ., N. Y.). Phys. Rev., D; 4: No. 4, 1080-97(15 Aug 1971).

An infinite number of sum rules is derived for the scattering processes involving any finite number of spinless particles. Each sum rule involves a finite number of partial-wave amplitudes from direct and crossed channels. These sum sules are implied by the crossing symmetry of the system and are complete. These sum rules are classified into an independent set, thus obtaining a basis for multivariable expansion. This basis displays the threshold and pseudothreshold zeros and kinematic singularities of the partial waves. (auth)

3438 SELF-CONSISTENT POMERANCHUKON SINGULARITIES. I. Bronzan, J. B. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 4: No. 4, 1097-1109(15 Aug 1971).

A functional self-consistency equation is formulated for the Pomeranchukon pole trajectory. The only ingredients are unitarity in the t channel (the channel of the Pomeranchukon) and the specification of $\alpha(0)$. The three solutions studied here are: $\alpha(0) = 1$, cut dominant; $\alpha(0) = 1-\epsilon$, cuts dominant: and $\alpha(0) = 1$, pole dominant. Expressions are provided for the t-channel partial-wave amplitudes in terms of a small number of free parameters; these expressions are adequate for the calculation of the high-s behavior of σ_{tot}, $\mathrm{Re}F(s, 0)/\mathrm{Im}F(s, 0)$, and the diffraction peak in the domain $|t[\ln(s/s_0)]/[\ln \ln s/s_0]| \lesssim$ constant. Three prominent conclusions are: (1) multi-Pomeranchukon phase space plays a leading role in determining the relative pole-cut strength; (2) there are fixed cuts in the vacuum partial-wave amplitude that accumulate at $j = 1$ even when $\alpha(0) = 1 - \delta$; (3) Schwarz trajectories $\alpha(t) = 1 + \gamma t^{\frac{1}{2}} + \ldots$ have a special status. (auth)

3439 COORDINATES AND DEMOCRACY IN THE N-BODY PROBLEM. Galbraith, Harold W. (Univ. of Pennsylvania, Philadelphia). J. Math. Phys. (N. Y.); 12: No. 11, 2382-6 (Nov 1971).

It is shown that the construction of "democratic" subgroups of 0_{3N-3} in the N-body problem is greatly facilitated by the "proper" choice of relative vectors in the center of mass frame. The work "proper" is taken to mean that the set of $(N-1)$ relative vectors forms a basis for reduced representations of the corresponding democracy subgroup of S_N. The imposition of this requirement easily leads one to the reduction chains $O_6 \subset SU_3 \supset SO_3^{rot}$ and $O_9 \supset SO_3^I \times SO_3^J \supset SO_3^{rot}$ in the three- and four-body problems, respectively, and to $O_{3N-3} \subset SO_{N-1} \times SO_3^{rot}$ in the $N > 4$ case. (auth)

3440 PHASE SHIFT. I. AS A BOUNDED FUNCTIONAL. Frank, William M. (Naval Ordnance Lab., White Oak, Md.). J. Math. Phys. (N. Y.); 12: No. 11, 2348-54(Nov 1971).

Classes of potentials are defined by the finiteness of certain norms. For potentials in any of these classes, the phase shift for any partial wave is shown to possess a norm-dependent bound as a function of energy. Two norms are adduced in which the phase shift is uniformly bounded for all energies. A number of theorems are proven concerning the high-energy behavior of the phase shifts corresponding to potentials in these classes. (auth)

3441 INTEGRAL APPROXIMATIONS IN POTENTIAL SCATTERING. Burt, P. B.; Woods, F. J. (Clemson Univ., S. C.). J. Math. Phys. (N. Y.); 12: No. 11, 2275-80(Nov 1971).

A development of the scattering amplitude in potential scattering which is based upon replacing a smooth potential by a sequence of potential steps is given. The Schrödinger equation is solved exactly in each internal over which the potential is constant and by matching boundary conditions; an expression relating the coefficients of two linearly independent solutions at small radius to those at large radius is found. From this the scattering amplitude is calculated. The limits of validity are found to be dependent upon the value of the expression $(r/2)(d/dr)\ln\{(2m/\hbar^2)[E-V]\}$. Limiting cases of the amplitude are shown to be a modified WKB approximation and the Born approximation. A particular application to the Yukawa potential is discussed. The discussion is restricted to attractive potentials. (auth)

3442 T-MATRIX ANALYTICITY USING FREDHOLM THEORY. Shaffer, Gedaliah R. (Princeton Univ., N. J.). J. Math. Phys. (N. Y.); 12: No. 11, 2302-5(Nov 1971).

The behavior of the Regge pole residues for the T matrix analyzed into partial waves is studied as a function of E for scattering from a Yukawa potential. Using a variational formulation of Fredholm theory, it is explicitly shown that the residues on the energy shell have no branch cuts in the left-hand E plane. (auth)

3443 REPRESENTATION OF THE SCATTERING AMPLITUDES IN THE FORM OF CONTINUAL INTEGRALS IN QUANTUM FIELD THEORY. Matveev, V. A.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 9: No. 1, 44-59(Oct 1971). (In Russian).

For simple models of quantum field theory a new representation for scattering amplitudes is deduced in the form of continual integrals over paths of particles. The problem of the mass and wave function renormalization is discussed and the generalization to inelastic amplitudes is given. (auth)

3444 PROPERTIES OF X-TYPE VENEZIANO AMPLITUDE. I. Nakkagawa, Hisao; Bando, Masako; Hattori, Toshihiko (Kyoto Univ. Tokushima Univ., Japan). Progr. Theor. Phys. (Kyoto); 46: No. 2, 468-85(Aug 1971).

The repulsive structure of the X-type Veneziano amplitude (V(t,u)) in exotic channels is concluded by the following assumptions: the positiveness of the resonance residue, the absence of exotic resonances and crossing symmetric properties of the scattering amplitude. (auth)

3445 BOUNDS ON THE ASYMPTOTIC BEHAVIOR OF AN ELASTIC SCATTERING AMPLITUDE NEAR THE FORWARD DIRECTION. Takagi, Fujio (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 46: No. 2, 559-76(Aug 1971).

Upper and lower bounds on the asymptotic behavior of Im $F(s,t) \equiv A(s,\nu)$ and its higher derivatives on ν for large s with ν fixed to small non-positive values are derived using the results from axiomatic quantum field theory. Here, F(s,t) is a certain elastic scattering amplitude, s and t are the usual Mandelstam variables, $\nu \equiv t(\ln(s/s_0))^2$ and s_0 is an unknown scaling factor. In connection with these bounds, it is proved that A(s,ν) and its higher derivatives on ν can be expanded into a power series of ν for large s and the higher order terms can be neglected even when s goes to infinity if ν is fixed to a sufficiently small value. An upper bound on the position of the zero of A(s,ν) as a function of ν(for large s) is derived and is compared with the result of Bessis. (auth)

3446 CONSISTENCY CONDITIONS ON THE CUT STRENGTH OF THE SELF-REPRODUCING POMERON. Fujisaki, Haruo (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 46: No. 2, 577-89(Aug 1971).

Consistency conditions on the discontinuity across the self-reproducing Pomeron are investigated by the use of modified Reggeon-unitarity conditions for coupled channels. Under the assumption of a standard parametrization of discontinuity, it is shown that the cut strength is factorizable in the immediate neighborhood of the Pomeranchuk branch point, and that the divergent self-reproducing Pomeron is consistent with the coupled-channel unitarity. It is also argued that unique determination of the cut strength of the Pomeron will be impossible on the self-consistency basis of the universality of the Pomeron and the coupled channel unitarity. All of these properties are irrespective of whether the Pomeron is a fixed branch cut or a pair of colliding branch cuts. (auth)

Particle Accelerators

Refer also to abstract 2131.

3447 (CEA-N-1457) SPACE CHARGE EFFECTS IN PROTON LINEAR ACCELERATORS. Prome, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jul 1971. 190p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay (France). Faculte des Sciences.

An attempt was made to explain the physical mechanisms which are responsible for space charge effects in a proton accelerator. The method chosen involves a numerical simulation of the beam; computer programs describing beam dynamics with space charge effects are presented; they are used to check results obtained elsewhere. A series of experiments was performed demonstrating that coupling phenomena produce an equalization of r.m.s. velocities in the 3 directions; a new quantity (a sort of hyperemittance) is introduced: its growth between the input and output of a given linac is proportional to the beam intensity. (auth) (France)

3448 (CERN-71-21) RADIATION PROBLEMS ENCOUNTERED IN THE DESIGN OF MULTI-GeV RESEARCH FACILITIES. Goebel, K. (ed.) (European Organization for Nuclear Research, Geneva (Switzerland)). 29 Sep 1971. 163p. Dep. NTIS (U. S. Sales Only).

Topics include the requirements for radiation protection, the interaction of protons in machine components and beam loss distributions, hadronic and electromagnetic cascades, experimental methods, estimate of the hadronic cascade initiated by high-energy particles, shielding against muons, transmission along ducts and skyshine, induced radioactivity, radiation-induced damage to machine components and radiation heating, and remote-handling equipment and its use in accelerators. (W.H.K.)

3449 (CERN-Trans-71-24) INVESTIGATION OF PHASE DENSITY REDISTRIBUTION IN REAL CHARGED PARTICLE BEAMS WITH THE HELP OF NUMERICAL CALCULATIONS. Kuznetsov, V. S.; Fidel'skaya, R. P.; Kuznetsova, N. P.; Solnyshkov, A. I.; Abroyan, M. A. Translated by B. Schnizer (CERN, Geneva, Switzerland), from pp 419-25 of Proceedings of the All-Union Conference on Particle Accelerators, Moscow, 9-16 October 1968. Volume II. 9p. (CONF-681029-5). Dep. NTIS (U. S. Sales Only).

The distribution function of the phase space density of particles in a beam satisfies the system of equations for the self-consistent field. The method used in calculating the redistribution of phase density in the proton beam of the injector I-100 is described. It is found that the current density distribution in a beam cross section is essentially nonuniform and has qualitatively different form for different cross sections, and that the beam envelopes are not symmetrical with respect to the cross section corresponding to the minimal size of the current of charged particles. The calculated current density distribution agrees qualitatively with the measured one. (R.W.R.)

3450 (CONF-711021-1) ELECTRON CYCLOTRON RESONANCE IN A PENNING ION SOURCE. Fuchs, G. (Oak Ridge National Lab., Tenn.); Steyaert, J.; Clark, D. J. (California Univ., Berkeley. Lawrence Berkeley Lab.). [1971]. 3p. Dep. NTIS.

From International conference on multiply-charged ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971).

Electron cyclotron resonance was detected in a Penning source by measuring the electron temperature as obtained from the x-ray emission spectrum. The resonance is only present if flat cathodes are used. (auth)

3451 (DESY-SR-71/4) GRAZING INCIDENCE VACUUM ULTRA-VIOLET MONOCHROMATOR WITH FIXED EXIT SLIT. Dietrich, H.; Kunz, C. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Aug 1971. 37p. Dep. NTIS (U. S. Sales Only).

A new monochromator with parallel incident light, a fixed exit aperture, and higher order rejection properties has been built and tested with the 7.5 GeV electron accelerator DESY which was used as a synchrotron light source. The parameters of the instrument are chosen to match the source characteristics at DESY. The exit beam is focused on a spot of 50 μm × 300 μm at the exit slit yielding about 10^7 monochromatic photons/sec at the maximum intensity (100 Å). The resolution attained is about 500 over the whole range 40 to 350 Å. Virtually no higher order admixing occurs in this range. The instrument can be used up to 1000 Å in a different mode of operation with less ideal performance. (auth)

3452 (DNPL/P-30) RADIATION "SKYSHINE" PROBLEMS ASSOCIATED WITH GeV ELECTRON BEAMS EXTRACTED INTO OPEN-TOPPED EXPERIMENTAL AREAS. Coleman, F. J.; Thomas, D. C. (Daresbury Nuclear Physics Lab. (England)). Mar 1970. 22p. (CONF-700505-28). Dep. NTIS (U. S. Sales Only).

From second congress of the international radiation protection association, Brighton, England (3 May 1970).

The 5 GeV electron synchrotron accelerator at Daresbury Nuclear Physics Laboratory has provided two extracted electron beams of up to 0.6 μA intensity. These beams are extracted into open-topped experimental areas equipped with very large spectrometry apparatus. "Skyshine" from such beams can produce relatively high radiation levels in the immediate environment of the experimental hall. Such levels can severely restrict other work in nearby areas or, alternatively, limit beam intensities thus interfering with the experimental program itself. The radiation is composed of a mixture of neutrons and photons in varying dose equivalent ratios, the main component being neutrons in nearly all cases. Radiation surveys, using conventional portable monitors are discussed. Location of the sources of the "Skyshine" has been attempted using an overhead scanning technique. The electron beam paths have been scanned using a simple collimated radiation monitor. Conclusions drawn from the overhead scans have been substantiated by induced activity measurements made on the various beam-line components and by subsequent beam profile measurements using TLD(LiF) dosimeters and ion chambers. A significant penumbra was found accompanying the beam. The quality of this penumbra was assessed using moderated indium foils, TLD, carbon-11 and other activation detectors. From these measurements it was found that the "Skyshine" problem could be reduced with improved beam transport, more careful positioning of experimental equipment and shielding within the area and by sensibly designed local shielding around ancillary beam-line equipment, such as beam intensity monitors, collimators, etc. With such improvements implemented, the requirements for higher beam intensities and lower backgrounds can be satisfactorily achieved and the health physics problems reduced. (auth)

3453 (EFI-ME-6(70)) TARGET REMOTE CONTROL ARRANGEMENT. Khurshudian, L. S.; Aganiants, A. O. (Akademiya Nauk Armyanskoi SSR, Erevan. Institut Fiziki). 1970. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

A simple device for a target remote control by means of which the direction selection of the target movement and its position are automatically accomplished is described. (auth)

3454 (FRNC-TH-94) DEVELOPMENT AND CONSTRUCTION OF A BEAM EXTRACTION DEVICE FOR A CYCLOTRON. Seret, Jacques (Bordeaux Univ. (France)). 1971. 53p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A beam extractor system using a peeler–regenerator was developed and constructed for the cyclotron of the Bordeaux–Gradignan Nuclear Research Center. The principle is described. The electric fields created near the extraction radius produce radial oscillations which are amplified at each cycle; as a consequence, the beam is displaced and tends to escape from the magnetic configuration of the cyclotron. This magnetic configuration and the shape of the beam near the extraction radius were experimentally determined, the beam being simulated by particles whose trajectories had been calculated for several revolutions across the extraction system. The effect of the various parameters was studied. The system assures a beam extraction of about 2 cm after only a few cycles. The system possesses the following characteristics: angular width of the deflectors 25 deg; voltages applied to the electrodes = 0 ± 30 kV; initial radius of the deflecting zone = 260 mm; radial width of the deflecting zone = 10 mm. (France)

3455 (IFVE-SKU-70-86) MEASUREMENT OF FREQUENCIES OF BETATRON OSCILLATIONS AT THE IHEP ACCELERATOR AT MIDDLE AND HIGH ENERGIES. Gertsev, K. F.; Gridasov, V. I.; Kuzmin, A. A.; Myznikov, K. P.; Senatorov, G. F. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

The method of a measurement of frequencies of betatron oscillations in the IHEP proton synchrotron at medium and high energies is described. The results of measurements are given as a function of the radial beam position at different levels of a magnetic field induction of the accelerator. (auth)

3456 (IFVE-SKU-70-90) DAMPING OF THE EFFECT OF THE INCREASE OF BEAM DIMENSIONS DUE TO THE INFLUENCE OF NONLINEAR RESONANCES AT THE IHEP ACCELERATOR. Gridasov, V. I.; Myznikov, K. P.; Cheredin, V. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

The dependence of beam dimensions on the value of the accelerator magnetic field is investigated. It is shown that the effect of increasing the beam dimensions is due to action of nonlinear resonances. The method of damping the above-mentioned effect has been experimentally investigated. (auth)

3457 (ITEF-812) VARIATION OF THE OSCILLATION AMPLITUDES OF LINEAR OSCILLATORS CROSSING THE SECOND-ORDER RESONANCE. Zenkevich, P. R. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

Variation of the oscillation amplitudes of linear oscillators crossing the second-order resonance (half-integer resonance or coupling resonance) is theoretically investigated. The transfer matrices for the ampitudes are determined. This method may be applied to investigate other accelerator theory problems. (auth)

3458 (IYAF-40-70) IRONLESS AND IRON-CONDUCTOR MAGNETS AND LENSES WITH THICK WINDINGS FOR ACCELERATORS. Davidovskii, V. G. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1970. 104p. (In Russian). Dep. NTIS (U. S. Sales Only).

Formation of stationary two-dimensional magnetic fields by ironless and iron-conductor magnets and lenses with windings of arbitrary thickness which tightly surround the domain of formation is considered. For magnets and lenses with circular and elliptical domain, analytical expressions for magnetic fields in metal of windings are found. Numerical solution of boundary equations at the outer boundary of windings allows one to define the shape of the boundary. The cases of ironless magnets and lenses (unscreened as well as screened by iron or current) and iron-conductor ones are considered in detail. The method is applied to calculations of ironless and iron-conductor magnets and lenses with circular domain. The results of numerical calculations of the shapes of the windings of various thickness and energy distributions are given for the cases of dipole and quadrupole magnets and lenses as well as for constant gradient field magnets (with horizontal or vertical planes of symmetry). For magnets and lenses with a rectangular domain a method of calculation is pointed out and a brief review of quadrupole lenses is given. (auth)

3459 (JINR-P9-6027) CALCULATION OF THE MOTION OF INTENSE BEAMS OF RELATIVISTIC PARTICLES IN SILUND. Kovalenko, A. D.; Parish, D.; Ryl'tsev, L. I.; Sarantsev, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1971. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

The motion of an intense relativistic electron beam in the longitudinal electric and magnetic fields is calculated in the paraxial approximation. Some relations are given for the estimation of the critical and cutoff potential which are due to the self-magnetic field of the beam. The motion of a particle in the transition region $\partial B_z/\partial z \neq 0$ is considered. The obtained results have been used in designing the high-current induction linear accelerator of nanosecond range (SILUND). (auth)

3460 (JINR-P9-6048) MEASUREMENT OF THE PARTICLE REVOLUTION FREQUENCY IN THE ELECTRON MODEL OF THE RING CYCLOTRON. Novikov, D. L.; Onischenko, L. M.; Shishlyannikov, P. T. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

If the beam circulates at a fixed radius without acceleration, the frequency of the signal induced by this beam on the pick-up electrode equals its revolution frequency. For measuring the frequency of this signal a special storing digital frequency meter is used. To increase the accuracy of the frequency determination, which depends on the measuring time, many cycles of rf voltage modulation are used to increase the total measuring time. The measured revolution frequency coincides with that predicted within 1 KHz; i.e., the accuracy of revolution frequency determination equals 2×10^{-5}. High-accuracy measurement of revolution frequency in an isochronous cyclotron may be useful for the computer correction of the average magnetic field "by the beam". (R.W.R.)

3461 (JPRS-54479) MEASURING AND MONITORING THE SPATIAL CHARACTERISTICS OF EXTERNAL BEAMS OF THE EREVAN RING ELECTRON ACCELERATOR. Arkelyan, G. A.; Vartanyan, G. S.; Esin, S. K.; Karabekov, I. I.; Kotsinyan, A. M.; Martirosyan, M. A.; Nazaryan, Yu. R. Translated from Prib. Tekh. Eksp.; No. 4, 46-8(1971). 6p. NTIS.

Apparatus are proposed which make it possible to determine the amount of current of accelerated particles which deflect onto the internal target, the vertical electron beam position at the instant of deflection and at the point of deflection; and also an apparatus is proposed which makes it possible to determine the position of the gamma beam's center of gravity. Methods for using the information obtained for regulating the accelerator parameters in the ejection stage are considered. (auth)

3462 (LA-4773(Pt.1)) HRS SPECTROMETER SYSTEM. I. CONCEPTS AND DESIGN. Zeidman, B. (Los Alamos Scientific Lab., N. Mex.). Oct 1971. Contract W-7405-eng-36. 48p. Dep. NTIS.

Specifications for the proposed magnetic proton spectrometer facility for the Los Alamos Meson Physics Facility are presented. The analyzer utilizes a quadrupole–dipole–dipole arrangement with a mean radius of curvature of 3.5 meters so that 800-MeV protons can be analyzed at 14 kG. Research proposals for the facility are summarized. (W.H.K.)

3463 (LA-DC-9789) DESIGN STUDY OF A π^- BEAM FOR BIOMEDICAL APPLICATIONS AT LAMPF. Thiessen, H. A. (Los Alamos Scientific Lab., N. Mex.). [nd]. 16p. (CONF-680734-1). Dep. NTIS.

From Pion Committee review meeting; Washington, D. C. (23 Jul 1971).

The results of a preliminary design study for a biomedical π^- beam facility at LAMPF are described. The goal of the study was to design a beam which would be eminently satisfactory for preliminary radiobiological experimentation and which could eventually be applied to radiotherapy. An essential part of this study was a calculation of the depth dose characteristics of the π^- beam. (auth)

3464 (LBL-42) USE OF RF-KNOCKOUT FOR DETERMINATION OF THE CHARACTERISTICS OF THE TRANSVERSE COHERENT INSTABILITY OF AN INTENSE BEAM. Moehl, Dieter; Sessler, Andrew M. (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1971. Contract W-7405-eng-48. 21p. (CONF-710908-3). Dep. NTIS.

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The response of an intense beam of interacting particles to a deflecting rf signal is computed theoretically and shown to be closely related to transverse coherent beam stability. It is shown that the beam response to sinusoidal excitation provides a direct measure of the stability of beam modes for given machine conditions (beam intensity, octupole current, sextupole current, momentum spread, etc.). This measurement includes the properties of the beam surroundings as well as the frequency spread effective

for Landau damping. Since it is generally difficult to evaluate theoretically the wall and beam properties that enter into stability calculations, the information that can be obtained from rf excitation experiments should be very valuable, especially in devising practical procedures for reducing the severity of coherent transverse instabilities. (auth)

3465 (LBL–307) EMITTANCE MEASUREMENTS ON AN ABERRATED CYLINDRICALLY SYMMETRICAL PROTON BEAM. Allison, Robert W. Jr.; Richter, Robert M.; Zajec, Emery (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1971. Contract W-7405-eng-48. 4p. (CONF-711012-12). Dep. NTIS.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

Four-dimensional emittance measurements were made on an aberrated cylindrically symmetric proton beam. These measurements indicate that, even in the presence of nonlinear effects, radial symmetry is maintained and most of the beam emittance occurs in the radial plane. The presence of magnetic field at the plasma cup was observed to create a strong nonlinearity when the beam is tightly focused. (auth)

3466 (LYCEN–7121) DEVELOPMENT OF A MEANS OF DIALOGUE IN ACQUIRING DATA AT THE LEVEL OF A DISPLAY UNIT. Cheval, Jean-Louis (Lyon Univ. (France). Institut de Physique Nucleaire). May 1971. 72p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Lyon Univ. (France).

The system presented permits two important operations to be performed at the level of the display console: the designation of the spots (spectra channel), and the tracing of a curve. Once these operations have been performed, the system can be adapted to meet the particular needs of the physicist. Some prehandling functions are given as examples. Interesting extensions of the system exist. These extensions have the advantage of facilitating the interpretation on the screen, and of possessing a certain flexibility of operation, readily demonstrated using a photosensitive pencil. The data support (histograms) remain unchanged. The limits of the system are indicated. The display system is not sufficiently powerful to enable all the possible images to be presented. The regeneration rate imposes a maximum spot density, not to be exceeded. For example, the MENU displayed must be decomposed into several separately presented menus; the axes are eliminated, and the results are displayed in the most simple manner possible. (France)

3467 (ORNL–4736) ANALYSIS SUBROUTINES FOR THE NUCLEON–MESON TRANSPORT CODE NMTC. Armstrong, T. W.; Chandler, K. C. (Oak Ridge National Lab., Tenn.). Nov 1971. Contract W-7405-26. 59p. Dep. NTIS.

Several subroutines for analyzing the transport data generated by the nucleon–meson transport code NMTC are described. The principal subroutines compute: flux and current from boundary crossings, flux from collision densities, residual nuclei distributions, and star densities in emulsions. Various auxiliary subroutines are also described. (auth)

3468 SUCCESSFUL BONDING METHOD FOR ION SOURCES. Thompson, D. T.; Copple, W. P. (Washington State Univ., Pullman). Nucl. Instrum. Methods; 96: No. 3, 475(1971).

A bonding method for accelerator ion sources using a commercially available vinyl resin is presented. This method has been applied successfully to a vertical Van de Graaff machine. (auth)

3469 FIVE-PARAMETER BEAM FOCUS MONITOR FOR TANDEM ACCELERATORS. Sharp, F. J.; Weber, A. C. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instrum. Methods; 96: No. 3, 477–9(1971).

A five parameter intensity modulated circular oscilloscope display, "Speedo-beam," has been designed for quick visual assessment of the focus and alignment of an accelerator beam. The monitor allows a simultaneous visual presentation of the beam current passing through an aperture into a Faraday cup. (auth)

3470 FURTHER EXPERIENCE WITH A FAST-CLOSING PROTECTIVE VALVE. Hahn, R. L.; Stone, R. L.; Tarrant, J. R.; Hunt, L. D.; Mallory, M. L. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 96: No. 3, 481(1971).

Experience under actual operating conditions at the Oak Ridge Isochronous Cyclotron demonstrates that a fast-valve system, with a large opening (6.35 cm) and no special baffles, works successfully. (auth)

3471 NANOSECOND PULSED BEAM EXPERIMENTS AT THE HEAVY ION CYCLOTRON. Hagemann, U.; Neubert, W.; Schulze, W.; Stary, F. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 96: No. 3, 415–19(1971).

The experimental arrangement has been installed at the 3 m heavy ion cyclotron in Dubna to perform spectroscopic in-beam measurements. By making use of the natural beam bunching, isomeric states with lifetimes down to 10 ns can be measured. The gamma radiation is detected by a planar Ge(Li) detector. (auth)

3472 GASEOUS TARGET SCATTERING CHAMBER. Wery, M.; Riehl, F. (CRN, Strasbourg). Nucl. Instrum. Methods; 96: No. 3, 425–9(1971). (In French).

A charged particle gaseous target scattering chamber installed on a Van de Graaff at C.R.N., Strasbourg is described. Its operating properties are discussed, and detailed design parameters for the differential pumping system are given. Some experimental data are presented. (auth)

3473 GRADED PLANE, HIGH-VOLTAGE ACCELERATOR. Peoples, Joseph T.; Luce, George A. (to Nuclear-Chicago Corp.). U. S. Patent 3,602,827. 31 Aug 1971. Filed 5 Apr 1968.

A high-voltage electron accelerator system employing a graded plane power supply, a graded plane accelerator, and a single, graded-conductor cable interconnecting the power supply and the accelerator is described. (auth)

3474 EFFECTS OF RADIATION ON SURFACE RESISTANCE OF SUPERCONDUCTING NIOBIUM CAVITY. Halama, H. J. (Brookhaven National Lab., Upton, N. Y.). Appl. Phys. Lett.; 19: No. 4, 90–1(15 Aug 1971).

The first measurements of radiation damage in a superconducting niobium cavity operated at microwave frequencies were made. It is shown that even a rather low radiation level of 10^{15} protons/cm^2 with an energy of 175 MeV increases significantly the residual surface resistance at high power levels. These data are pertinent to the construction of superconducting linear accelerators. (auth)

3475 CONSTRUCTION AND OPERATION OF TWO SUPERCONDUCTING QUADRUPOLE LENSES. Marquet, M.; Morpurgo, M. (CERN, Geneva). Cryogenics; 11: No. 5, 412–3(Oct 1971)

Two superconducting quadrupole lenses were constructed and successfully operated as elements of a hyperon beam. The beam consisted of two deflecting magnets and of two small sized superconducting quadrupoles located in the dead space between the magnet coils. The overall beam length was barely larger than the sum of the two magnet lengths. The two lenses had identical cross-sections and lengths of 30 and 60 cm, respectively. The quadrupoles produced (with a useful diameter of 3 cm) a maximum field gradient of 14200 g cm^{-1} when fed by a current of 110 A. The lenses had cobalt steel poles and yokes which together with the four superconducting coils were cooled by liquid helium. The construction details and the operating conditions of the quadrupoles are given. The system is fully automatic. (UK)

3476 SELECTION OF OPTIMUM PARAMETERS FOR RESOLVING THE REMAINDER OF THE DIRICHLET PROBLEM ANALOG IN CYLINDRICAL GEOMETRY. Dyldina, R. T.; Enal'skii, V. A. Zh. Vychisl. Mat. i Mat. Fiz.; 10: No. 3, 685–92 (May–Jun 1970). (In Russian).

The acceleration process in a strong-current ion linear accelerator was programmed for an IBM computer using the method suggested by D. Peaceman et al. (J. Soc. Industr. and Appl. Math., 3: No. 1, 28(1955)). In order to conserve computer time, in the case of $R \ll L$, it was necessary to select the iteration parameters considering the properties of the difference operator which approximated the differential operator $(1/r)(\partial/\partial r)r(\partial/\partial r)$. An attempt was made to select parameters for such a case. (R.V.J.)

3477 STOCHASTIC PARTICLE ACCELERATION IN ELECTROMAGNETIC FIELDS. Helmis, G. (Zentralinstitut Physik der Erde, Jena, Ger.). Ann. Phys. (Leipzig); 26: No. 1, 29–37 (1971). (In German).

The mean energy change per unit time of a charged particle in an electromagnetic decay field is calculated. The electromagnetic field is determined by the turbulent motion of a plasma in an external homogeneous magnetic field. The turbulent motion of the medium was assumed as stationary, homogeneous, and isotropic, and generally as nonmirror symmetrical. It is shown that the result depends essentially on the special selection of the correlation tensors of the velocity field. The correlation between the electric field and the magnetic field modify significantly the acceleration process. (tr-auth)

3478 PROTECTION OF A SYSTEM OF ELECTRONIC MODULES FROM CHANGES IN POWER-SUPPLY VOLTAGE. Khurshudyan, L. S. (Inst. of Physics, Erevan). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 193–4(Jan–Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 164-5(Jan-Feb 1971).

A device for protecting a system of electronic modules which ensures automatic disconnection of all power supplies when there is substantial change (decrease or increase) of any one of the supply voltages of the modules is described. (auth)

3479 FORMATION OF COMPLEX MAGNETIC CYCLES IN A 7-GeV PROTON SYNCHROTRON. Kleopor, I. F.; Kugushev, G. I. (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 12-17 (Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 19-24(Jan-Feb 1971).

The principles of designing universal systems for controlling ignitron converters are described. Systems are designed for successive formation of main magnetic cycles with one or two smooth transitions from positive values of the field derivative dH/dt = 4 to 9 kOe/sec to any stipulated value $dH/dt \leq 0$ (for slow guiding of the beam onto the target), as well as abridged triangular cycles for extraction of a proton beam having an energy ~200 MeV in the interval between the main cycles. The procedure of forming such cycles is demonstrated for operation of the power-supply system of a ring magnet in a mode of 30 cycles/min. (auth)

3480 STABILIZATION OF THE INSTANTANEOUS INTENSITY OF THE GAMMA RADIATION OF A SYNCHROTRON RELATIVE TO THE SYNCHROTRON RADIATION. Vizir, V. A.; Nikitin, M. M. (Tomsk Polytechnic Inst., USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 18-19(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 25-6(Jan-Feb 1971).

A system for stabilizing the instantaneous intensity of gamma-bremsstrahlung of a synchrotron is described. A photoelectron multiplier which records synchrotron radiation is used to sense the accelerated current. For an acceleration-cycle duration of 60 msec the maximum length of the radiation pulse reaches 40 msec. (auth)

3481 ACCELERATION OF MULTIPLY CHARGED IONS IN SECTIONED TUBES WITH INCLINED FIELDS. Serbinov, A. N. (Inst. of Atomic Energy, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 20-2(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 26-8(Jan-Feb 1971).

The singularities of using three-element sections to assemble an accelerator tube with inclined fields in an electrostatic charge-exchange generator designed for accelerating heavy ions which develop after conversion of a beam of negative ions on a strip target are considered. The dependence of the trajectories of the ions on ion charge multiplicity determines the requirements governing the high energy tube construction: the necessity of large coefficients of preliminary acceleration and a change in the sign of the normal components of the inclined fields of the elements during the transitions from section to section. (auth)

3482 HIGH-INTENSITY BEAM OF NEGATIVE PARTICLES HAVING A MOMENTUM OF 10 TO 16 GeV/c. Golovnya, N. I.; Grachev, M. I.; Gubrienko, K. I.; (and others) (Inst. of High-Energy Physics, Serpukhov, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 23-5(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 29-31(Jan-Feb 1971).

A channel of secondary negative particles in the range of momenta from 10 to 16 GeV/c which has a beam intensity of up to 10^7 per accelerator operating cycle is described. The characteristics of the beam obtained are given, and the peculiarities of the optical scheme of the channel are discussed. (auth)

3483 CURRENT CONFIGURATIONS WHICH ENSURE RAPIDLY DECAYING AXISYMMETRIC MAGNETIC FIELDS. Lebedev, S. V. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 26-9(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 32-4(Jan-Feb 1971).

Two methods of describing coils which create rapidly decaying axisymmetric magnetic fields for focusing charged-particle beams are discussed. It is shown that by means of coils carrying a current that is continuously distributed with respect to length, one may obtain magnetic fields of an arbitrary type. In the case of a rapid decay of the magnetic field intensity the length of the coil is finite. In using a system having a finite number of discrete current-carrying coils one may achieve arbitrarily rapid decay of the magnetic field intensity. (auth)

3484 SUPERCONDUCTING QUADRUPOLE LENS. Vasil'ev, V. L.; Trokhashev, G. V.; Tikhomirov, V. F.; Churakov, G. F. (Scientific-Research Inst. of Electrophysical Equipment, Leningrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 30-2(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 35-6(Jan-Feb 1971).

Results of the development and investigation of a quadrupole superconducting lens having a stationary magnetic field are presented. Such lenses may be used in channels for the transportation of charged-particle beams. (auth)

3485 SOURCE OF NEGATIVE HELIUM IONS FOR A CHARGE-EXCHANGE ELECTROSTATIC ACCELERATOR. Khirnyi, Yu. M.; Kochemasova, L. N. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 33-5(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 37-9(Jan-Feb 1971).

A source of He^- ions having an intensity of 8 μA is described. Charge exchange of He^+ on a vapor-jet cesium target was used to obtain He^-. The gas discharged by the duoplasmatron source under these conditions was ~10 cm^3/h. (auth)

3486 SOURCE OF POLARIZED NEGATIVE DEUTERIUM IONS FOR A CHARGE-EXCHANGE ELECTROSTATIC ACCELERATOR. Khirnyi, Yu. M.; Kochemasova, L. N. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 36-41(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 39-44(Jan-Feb 1971).

A source of polarized negative deuterium ions is described. In order to obtain polarized ions the process of formation of atoms excited in the $2S_{\frac{1}{2}}$ state from 1.0-keV deuterons on a vapor-jet cesium target, the deexcitation of the three lower sublevels in a magnetic field, and selective charge exchange of the remaining excited neutral polarized beams into a negative beam on Ar were used. The intensity of the beam of D_1^- was approximately 0.04 μA, $P_{33} = -(0.267 \pm 0.008)$. (auth)

3487 FIELD-EMISSION GUN FOR A LINEAR ELECTRON ACCELERATOR. Bogdanovich, B. Yu.; Voronkov, R. M.; Gass, V. F.; Danilichev, V. A. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 42-5(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 44-6(Jan-Feb 1971).

The construction of a field-emission gun designed for the injection of electron bunches having a phase extent of 30 to 40° and an energy of 300 to 400 keV into a linear accelerator is described. An experimental investigation of the gun showed that when it was supplied with a uhf power of approximately 1 MW the gun produced an electron beam having a pulse current of approximately 1 A and an energy up to 500 keV. (auth)

3488 CATHODES USED IN THE GUNS OF LINEAR ACCELERATORS. Rybas, K. P.; Pavlov, V. K.; Babin, G. A. (Scientific-Research Inst. of Electrophysical Equipment, Leingrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 45-6(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 46-8(Jan-Feb 1971).

The possibilities of using cathodes of various types in linear electron accelerators were investigated. The most appropriate turned out to be a cathode consisting of lanthanum hexaboride and a pressed porous nickel–oxide cathode (a BN-cathode). These cathodes have a high resistance to contamination by remanent gases at a pressure of $2 \cdot 10^{-4}$ torr for an emission ≥ 1 A/cm^2; in the cold state they allow multiple exposure to air without loss of emission. (auth)

3489 USE OF THIN ORGANIC FILMS IN NUCLEAR PHYSICS EXPERIMENTS. Barit, I. Ya.; Balashko, Yu. G.; Dul'kova, L. S.; Zavarzina, V. P. (Inst. of Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 58-61(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 57-60(Jan-Feb 1971).

Experience in using films made of various organic substances and having a thickness of 1 to 2 μ as windows for a gas target in nuclear physics experiments is described. It is shown that polypyromellitimide (PM type) has a number of advantages over other materials which are used for this purpose. (auth)

3490 SYMMETRICAL STRIP LINE FOR SHAPING POWERFUL MICROSECOND PULSES. Shakhov, V. V. (Scientific-Research Inst. of Electrophysical Equipment, Leningrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 127-9(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 114-17(Jan-Feb 1971).

The use of strip lines for the shaping of powerful microsecond pulses is described. The basic formulas are given, as well as the results of tests on models. The pulse generator was studied for fast beam extraction at the Serpukhov Synchrotron. (auth)

3491 EXCITATION OF POWERFUL KIU-12 AMPLIFIER KLYSTRONS. Vladimirtsov, M. B.; Prosin, B. V.; Chernyi, S. A. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 1, 135-7(Jan-Feb 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 1, 121-2(Jan-Feb 1971).

A system is described for the excitation of a powerful KIU-12 klystron which guarantees a frequency stability of at worst $1 \cdot 10^{-6}$ f for smooth frequency tuning over a range of more than $\pm 10^{-3}$ f and a pulse length of 20 μsec. (auth)

3492 COLLECTIVE-EFFECT ACCELERATION ON ELECTRONS IN ELECTRON BEAMS. Coutu, A.; Heese, N. R.; Raudorf, W. R. (Univ. of Montreal). J. Appl. Phys.; 42: No. 11, 4504-6(Oct 1971).

Owing to a dynamic space-charge effect, a cylindrical stream of electrons, advancing in an evacuated metal tube continued by a plastic tube, is reflected at the junction of the tubes apart from the electrons constituting the front portion of the beam which become accelerated to many times their original energies. (auth)

3493 PROGRESS OF THE CERN–SERPUKHOV COLLABORATION. CERN Cour.; 11: No. 8, 211-20(Aug 1971).

The progress of the CERN–Serpukhov collaboration where CERN agreed to install a fast ejection system and an rf beam separator at the Serpukhov Synchrotron in return for experimental collaboration privileges at the synchrotron is described. The fast ejection system, beam transport system, rf separated line, Mirabelle, and collaborative experiments are discussed. (W.H.K.)

3494 HADRON-INDUCED SPECTRA FROM 200- AND 400-GeV PROTON INTERACTIONS. Santoro, R. T.; Gabriel, T. A. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 891-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3495 CHARGE DIGITIZATION BY RAPID INTEGRATION. Hudson, G. M.; Crinean, G. B. (Univ. of Melbourne, Parkville, Australia). Nucl. Instrum. Methods; 96: No. 2, 341-5(1971).

A description of a solid state beam current digitizer is given. The digitizer measures currents from 1 nA to 10 μA by dc current amplification followed by a gated conventional integrator employing transistor discharge. Accuracies better than ±0.15% over a 70:1 dynamic range are achieved inexpensively, and with a fast response analogue output. (auth)

3496 INVISIBLE LONG STRAIGHT SECTION FOR SYNCHROTRONS. Meads, P. F. Jr. (William M. Brobeck and Associates, Berkeley, Calif.). Nucl. Instrum. Methods; 96: No. 2, 351-4(1971).

A synchrotron insertion is described that leaves the linear orbit properties of the synchrotron invariant and yields a single unobstructed drift space containing nearly all of the available drift length in the insertion. (auth)

3497 MOMENTUM ANALYSER OF HIGH RESOLUTION. Miller, W. C.; Piowaty, J. M. (Univ. of Notre Dame, Ind.). Nucl. Instrum. Methods; 96: No. 2, 221-2(1971).

A two magnet system has been developed to give stigmatic focussing with unit magnification and a momentum dispersion over 3.5 times that obtained with a single magnet. (auth)

3498 STABILIZATION OF THE NOTRE DAME 7.5-MeV ELECTRON ACCELERATOR. Lewis, T. J.; Friesel, D. L.; Miller, W. C. (Univ. of Notre Dame, Ind.). Nucl. Instrum. Methods; 96: No. 2, 223-6(1971).

A modified HVEC model FN accelerator is being used as an electron accelerator for energies up to 7.5 MeV. A momentum analysis and stabilization system has been developed which permits electron beams to be defined within 0.05% in energy. The principal features of the system are a two-magnet momentum analyzer with a dispersion of 550 cm and stabilization of the terminal voltage by injection of a $^4He^+$ ion beam. The system has given good operation at terminal voltages up to 6 MV. (auth)

3499 ACCEPTANCE OF A CYCLOTRON AXIAL INJECTION SYSTEM. Hazewindus, N. (Philips Research Labs., Eindhoven, Netherlands). Nucl. Instrum. Methods; 96: No. 2, 227-33(1971).

Factors affecting the acceptance of an axial injection system (equipped with a plane electrostatic deflector) for a cyclotron are discussed. A numerical method of calculation is proposed. It is applied in the determination of the optimum beam convergence at the entrance of the axial injection system. The influence of the initial beam quality is shown. (auth)

3500 INEXPENSIVE HIGH BEAM CURRENT GAS CELL FOR NEUTRON PRODUCTION. Morris, C. L.; Thornton, S. T. (Univ. of Virginia, Charlottesville). Nucl. Instrum. Methods; 96: No. 2, 281-3(1971).

A gas cell for the production of neutrons in nuclear reactions has been constructed. Its advantages over previous gas cells are low mass, simple operation, inexpensive construction, ability to withstand high beam currents, and small energy loss of the beam through the entrance foil. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 2209, 2336, 2347, 3091, and 3500.

3501 (IEA-235) TOTAL NEUTRON CROSS SECTION AND THE EFFECTIVE ABSORPTION COEFFICIENT OF A Ge(111) SINGLE CRYSTAL. Fulfaro, R. (Instituto de Energia Atomica, Sao Paulo (Brazil)). May 1971. 12p. Dep. NTIS (U. S. Sales Only).

Using the IEA crystal spectrometer, the total neutron cross section of a Germanium single crystal was measured, for neutron energies between 1.0 to 0.01 eV, with the incident beam reaching the (111) planes perpendicularly. The energy behavior of the Ge(111) effective absorption coefficient has been obtained through a comparison between calculated curves of total cross section and the experimental results. The value θ = 370°K for the Ge Debye temperature was chosen among the several existing values for Ge. (auth)

3502 (JINR-14-5189) INTERACTION PROCESSES OF ULTRACOLD NEUTRONS WITH MATTER. Khennig, K.; Tempel'khoff, K.; Usmanova, Z. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1970. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

Various interaction processes of ultracold neutrons with matter are discussed. The use of ultracold neutrons to study effects associated with the variation of nuclear forces with spin is especially important for possible studies in the field of solid state physics. (tr-auth) (JPRS)

3503 (RD/B/N-1962) MIMUSA: A FORTRAN IV SUBROUTINE FOR UNFOLDING SPECTRA. PART I. THEORY, DISCUSSION, AND RESULTS. Longworth, J. P. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). May 1971. 42p. Dep. NTIS (U. S. Sales Only).

MIMUSA (Matrix Iteration Method of Unfolding Spectra) unfolds spectra in two stages. In the first stage an "error function" is minimized using a modified form of Gold's iterative matrix multiplication method. In the second stage the error function is further reduced by varying the spectral groups cyclically, using an addition method. The two main sources of uncertainty in the final spectrum are the errors in the experimental data and those in the unfolding procedure; MIMUSA calculates these effects independently. The theory is described and the results obtained with MIMUSA, using several types of response matrix, are discussed with special reference to results obtained with the DELTA neutron spectrometer. (auth)

3504 LINEAR ANISOTROPIC FIRST-FLIGHT PROBABILITIES FOR CYLINDRICALIZED WIGNER-SEITZ CELLS. Royl, P.; Emendoerfer, D. (Univ., Stuttgart). Atomkernenergie; 18: No. 2, 151-7(1971).

A simple method is developed for calculating first-flight collision probabilities for linear anisotropic scattering media in a circularly cylindrical cell. The contributions due to a white cell boundary are calculated. The method presented is exact within the constant source approximation for each zone; it thus differs from methods previously derived. A numerical example is given. This shows that the number of subregions that are necessary because of the constant source approximation generally can be kept smaller than in the isotropic case. Finally, a correction to the isotropic probabilities that accounts for linear anisotropic scattering in the Selengut-Goertzel approximation is derived. (auth)

3505 PLACZEK FUNCTIONS CALCULATED WITH SYNTHETIC KERNEL APPROXIMATION. Yamamura, Yasunori; Sekiya, Tamotsu (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 9, 531-3(Sep 1971).

Previously a synthetic kernel more accurate than the Greuling-Goertzel approximation was proposed. The technique proposed was of a nature that indicated the possibility of obtaining the synthetic kernel with any accuracy, according to the requirement of the problem. The collision densities calculated with Laplace transform exactitude (LTE) or a generalized synthetic kernel approximation (SKA) are expressed as sums of exponential functions of lethargy. For nonhydrogeneous matter one of the infinite number of terms from LTE is nonoscillatory. Here it is shown that the collision density from SKA has a nonoscillatory term and finite sums of exponential functions of lethargy. (M.H.R.)

3506 GROUP TRANSFER MATRICES AND THEIR RELATION TO BASIC CROSS SECTION DATA. Segev, M. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 45: No. 3, 269-78(Sep 1971).

The in-scattering sources in the group-Legendre expansion of the Boltzmann equation can be classified by four-index sources, four-index cross sections, or four-index kernels, depending on the type of multigroup approximation used. These four-index transfer elements are related to basic cross-section data through a general four-way logic that applies to narrow and wide groups alike, to heavy and light scatterers alike, and to elastic and single-level inelastic scattering alike. As an application of the logic, the effect of inelastic energy-angle correlation on the calculation of some reactor parameters is demonstrated. (auth)

3507 MULTIPLE SCATTERING OF THERMAL NEUTRONS BY A PERFECT CRYSTAL. II. CALCULATION OF APPROXIMATE VALUES FOR THE INFORMATION QUANTITIES. Solbrig, H. (Technische Hochschule, Karl-Marx-Stadt, Ger.). Phys. Status Solidi (b); 47: No. 1, 143-51(1 Sep 1971).

The general method of part I (Phys. Status Solidi(b) 46: 273 (1971)) is developed further to get explicit approximate solutions for the information parameters Q and X(Q) of this theory in the quasi-optical case, the symmetrical Laue case, and the symmetrical Bragg case. Starting from a formally exact method for computation of Q and X(Q), which is equivalent to that following from a theory using a differential equation, the basic approach of part I is introduced. The resulting equations are, in principle, equivalent to those of the Laue theory for x rays. (auth)

3508 RESONANCE NEUTRON MODERATION IN MATTER. III. Kozhevnikov, D. A.; Khavkin, V. S. This paper was summarized in At. Energ. (USSR); 29: No. 5, 365-6(Nov 1970) as paper No. 441/5823. (In Russian).

A form of the transport equation generalizing the Weinberg-Wigner-Korngold-Orlov equation to the general case of space-nonisotropic and nonstationary problems of the theory of neutron transport in multicomponent media with arbitrary energy dependence of the interaction cross sections has already appeared [Kozhevnikov and Khavkin, At. Energ. (USSR), 27, 142 (1969)]. This form of the transport equation is now used for the mathematical setup and formal (quadrature) solution of the general problem of moderator theory in determining the angle-, energy-, and time-dependent distribution function of neutrons in matter. On the basis of the formal solution various integral characteristics of the neutron distribution function are calculated, including the first and second time and angular moments, which are studied for sources with various angular distributions. (R.W.R.)

3509 SLOWING DOWN OF RESONANCE NEUTRONS IN MATTER. 4. Kozhevnikov, D. A.; Khavkin, V. S. This paper was summarized in At. Energ. (USSR); 29: No. 6, 448(Dec 1970) as paper No. 446/5893. (In Russian).

The time dependence of neutron age is examined. The analytic features of the complete formal solution of the steady-state slowing-down problem are studied. The spatial, angular, and energy distributions of neutrons close to the source are obtained in explicit form. This result has the same form for all spectral approximations. Results obtained are valid for an arbitrary energy dependence of the reaction cross sections and are easily generalized to take account of inelastic scattering and diffraction anisotropy. At large distances from the source the neutron spatial and energy distributions are determined by the character of the energy dependence of the total interaction cross section. (R.W.R.)

3510 COMMENT ON GREEN'S FUNCTIONS IN TRANSPORT THEORY. Leuthaeuser, Klaus-Dieter (Univ., Kiel). Atomkernenergie; 18: No. 2, 172(1971).

The correct application of the Poincare-Bertrand formula in neutron transport theory has been clouded because different interpretations of the formula yield formally different results for Green's functions in monoenergetic transport theory. These formal differences arise from the question of how to interpret the meaning of products of generalized functions inherent in the traditional representation of Green's functions. Representations given here avoid such formal difficulties. Consideration is given to the infinite-medium Green's function and the albedo problem. (R.W.R.)

3511 VARIATIONAL FIELD THEORY. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). J. Math. Phys. (N. Y.); 12: No. 11, 2296-2301(Nov 1971).

Equations which define a "consistent" set of "boundary" conditions, and hence a field, for a given set of differential equations are derived from a variational principle. The equivalence of functionals defined over an entire domain and functionals defined over

only a subdomain, but with a surface term added to account for the contribution of the excluded subdomain, is exploited. The appropriate surface term is found to satisfy the Hamilton–Jacobi equation. The formalism is specialized to neutron diffusion theory, and it is demonstrated that Stark's double sweep method follows as a natural consequence of this field theoretic formulation. The relation of this formalism to Pontryagin's maximum principle and Bellman's dynamic programming is demonstrated for problems which can be characterized by minimum variational principles. (auth).

3512 DIFFERENTIAL ALBEDO OF NEUTRONS FOR IRON AT A STRONGLY INCLINED INCIDENT BEAM. Germogenova, T. A.; Kobozev, M. G.; Suvorov, A. P. pp 339-50 of Byulleten' Informatsionnogo Tsentra po Yadernym Dannym. /Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). (In Russian).

The results of calculating the differential (with respect to the angle and the energy) albedo are given for broad monodirectional neutron beams incident on a 20-cm-thick layer of iron, which may be considered semi-infinite in extent for fast and thermal neutrons. Good agreement was obtained between differential (in angle and energy) albedo of neutrons and reactor spectrum of E > 200 keV for angles of incidence of the beam from 0° to 70°. For calculating various values of energy, constants were taken from the literature pertaining to iron. The several tables embrace a range of energy values from thermal to > 2.5 MeV. (K.S.W.)

3513 EXPERIMENTAL/CALCULATIONAL COMPARISON FOR 14-MeV NEUTRONS IN GRAPHITE. Jenquin, U. P.; Williams, L. D.; Wolkenhauer, W. C. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 447-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3514 NEUTRON YIELD AND ANGULAR DISTRIBUTION FROM HERMES-II COMPOSITE TARGETS. Bonzon, L. L.; Powell, J. E. (Sandia Labs., Albuquerque, N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 520(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3515 EVALUATION OF NEUTRON BEAMS USING GEOMETRICAL OPTICS. Kok, Kenneth D. Trans. Amer. Nucl. Soc.; 14: No. 2, 526(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3516 STUDY OF ITERATIVE SOLUTIONS FOR THE FINITE ELEMENT METHOD. Nakamura, S. (Ohio State Univ., Columbus); Ohnishi, T. Trans. Amer. Nucl. Soc.; 14: No. 2, 662(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3517 DUAL FINITE ELEMENT METHODS FOR NEUTRON DIFFUSION. Semenza, L. A.; Lewis, E. E.; Rossow, E. C. (Northwestern Univ., Evanston, Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 662-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3518 UFINV, A COMPUTER SYSTEM FOR INVARIANT IMBEDDING NEUTRON TRANSPORT CALCULATIONS. Mockel, A. J. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc.; 14: No. 2, 670-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3519 REDUCTION OF FEW-GROUP DIFFUSION THEORY TO ONE EQUIVALENT GROUP. Woolley, J. A. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 671-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3520 BENCHMARK CALCULATIONS FOR BRITISH AND LRL CROSS-SECTION SETS. Doyas, Richard J. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc.; 14: No. 2, 801-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3521 COMPUTATIONAL MERITS OF A TRANSPORT CONSISTENT DIFFUSION THEORY. Sullivan, H. S.; Sheaks, O. J. (Univ. of Maryland, College Park). Trans. Amer. Nucl. Soc.; 14: No. 2, 831-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3522 14-MeV NEUTRON TRANSPORT IN IRON. Ching, J.; Oblow, E.; Goldstein, H. (Columbia Univ., New York). Trans. Amer. Nucl. Soc.; 14: No. 2, 835(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3523 STUDY OF NEUTRON TRANSPORT IN DEPLETED URANIUM WITH AN ASSESSMENT OF DATA FILES. Kaushal, N. N.; Malaviya, B. K.; Burns, E. T.; Becker, M.; Gaerttner, E. R. (Rennselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 835-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3524 FAST-NEUTRON SPECTRA IN ALUMINUM. Golay, M. W.; Kaushal, N. N.; Malaviya, B. K.; Gibbs, D. C. (Rennselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 836-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3525 COMPARISON OF ENDF/B INELASTIC SCATTERING DATA WITH SPHERE TRANSMISSION EXPERIMENTS. Battat, Morris E.; Hansen, Gordon E. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 837-8 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3526 EFFECT OF ANISOTROPIC SCATTERING UPON THE ELASTIC MODERATION OF FAST NEUTRONS. Rao, R. S.; Ram, K. S. (Univ. of Cincinnati). Trans. Amer. Nucl. Soc.; 14: No. 2, 839-40(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3527 GENERATION OF FAST-NEUTRON GROUP CONSTANTS. Burns, Edward T.; Becker, Martin (Rennselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 840-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3528 NEUTRON WAVE PROPAGATION IN BERYLLIUM. Miles, R. E.; Parkinson, T. F.; Bull, S. R. (Univ. of Missouri, Columbia). Trans. Amer. Nucl. Soc.; 14: No. 2. 867-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3529 EXPERIMENTAL EVALUATION OF MINIMA AND SHALLOW-ANGLE-SCATTERING NEUTRON CROSS SECTIONS. Miller, W. H.; Meyer, Walter (Kansas State Univ, Manhattan). Trans. Amer. Nucl. Soc.; 14: No. 2, 902-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3530 COMPARISON OF CALCULATIONS USING ENDF/B MATERIAL 1124 NEUTRON DATA WITH EXPERIMENT. Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 922-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3531 O6R CALCULATIONS OF NITROGEN AND IRON LRL PULSED SPHERE EXPERIMENTS. Roussin, R. W.; Straker, E. A.; Morrison, G. W. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 925-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3532 EFFECT OF RECENT CROSS-SECTION EVALUATIONS ON NEUTRON TRANSPORT IN AIR. Harris, R. J. Jr.; Lonergan, J. A. (Science Applications Inc., La Jolla, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 926-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3533 LAST-COLLISION MODEL OF THE AIR-GROUND INTERFACE EFFECT ON FAST-NEUTRON ANGLE DISTRIBUTIONS. French, R. L.; Mooney, L. G. (Radiation Research Associates, Inc., Fort Worth, Tex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 927-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Nuclear Properties and Reactions, A≤5

Refer also to abstracts 3562, 3587, 3603–3606, and 3638.

3534 (AI-AEC-Memo-12639) AVAILABILITY OF ENDF/ NEUTRON CROSS SECTION DATA. Alter, H. (Atomics International, Canoga Park, Calif.). 8 Jan 1968. 50p. Dep. NTIS.

Over the past several months Brookhaven National Laboratory has been distributing ENDF/B Neutron Cross Section Data to participating members of the Cross Section Evaluation Working Group (CSEWG). This report summarizes data received and available for use at Atomics International as of January 1, 1968. (auth)

3535 (FRNC-CONF-9) QUASI-FREE p-p AND n-p SCATTERING IN THE BREAK-UP OF DEUTERONS BY PROTONS FROM 20 TO 60 MeV. Durand, J. L.; Arvieux, J.; Fiore, A.; Perrin, C. (Grenoble Univ. (France). Institut des Sciences Nucleaires). 1971. 34p. (CONF-710708–4). Dep. NTIS (U. S. Sales Only).

From Symposium on the nuclear three body problem and related topics; Budapest, Hungary (7 Jul 1971).

The (p,p) and (n,p) quasi-free scattering was studied in the same experiment. The data were compared with a simple spectator model and with a calculation of the inhomogeneous term of the rescattering graph series. Both calculations give the shape of the spectra but there is a discrepancy between calculated and experimental absolute values of the cross sections. (auth)

3536 (JINR-E4-5983) NEUTRON SPECTRUM AND ASYMMETRY OF THE ANGULAR DISTRIBUTION IN MUON CAPTURE REACTION. CAPTURE ON ^{4}He NUCLEI. Eramzhyan, R. A.; Fetisov, V. N.; Salganic, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 18p. Dep. NTIS (U. S. Sales Only).

The neutron channel in muon capture by ^{4}He is considered. The dependence of the energy spectrum and asymmetry of angular distribution in reaction $\mu^- + {}^4\mathrm{He} \rightarrow {}^3\mathrm{H} + n + \nu$ on relativistic terms of muon-nucleon Hamiltonian and final-state interaction is investigated. It is shown that the above mentioned factors are decisive in the description of the high energy part of the spectrum and asymmetry. (auth)

3537 FRESNEL DIFFRACTION IN DEUTERIUM. Gottfried, K. (CERN, Geneva). Ann. Phys. (N. Y.); 66: No. 2, 868–83(Aug 1971).

In Glauber's theory of high-energy scattering the wave function inside the nucleus is given by geometrical optics. The theory is extended to lower energies by incorporating the effects due to Fresnel diffraction, and applied to elastic and inelastic scattering by deuterium. (auth)

3538 INVESTIGATION OF THE $^3\vec{\mathrm{He}}(\vec{\mathrm{d}},\mathrm{p})^4$He REACTION WITH POLARIZED BEAM AND TARGET AT 430 keV. Leemann, Ch.; Buergisser, H.; Huber, P.; (and others) (Univ., Basel). Ann. Phys. (N. Y.); 66: No. 2, 810–15(Aug 1971).

The efficiencies of the $^3\vec{\mathrm{He}}(\vec{\mathrm{d}},\mathrm{p})^4$He reaction for selected combinations of deuteron and ^{3}He polarization were measured at E_d = 430 keV. An analysis of the data shows resonant element R_1 = (2, 1/2, 3/2$^+$| R| 0, 3/2, 3/2$^+$) to be the dominant contribution, while p- and d-wave admixtures amount to a few percent of R_1. (auth)

3539 NEGATIVE-PARITY EXCITED STATES OF THE ALPHA-PARTICLE. Hammann, T. (Laval Univ., Quebec. Institut d'Etudes Nucleaires, Algiers); Monsonego, G. Nuovo Cim., 6A: No. 1, 49–61(1 Nov 1971).

The results are presented of a study of the alpha-particle structure using a realistic nonlocal potential. The spectrum of the negative-parity states appears in excellent agreement with the results of a recent experimental analysis. A detailed examination of various level splittings, which depend in a simple manner on different types of forces, allows some interesting conclusions to be drawn on the choice of alternative sets of potential parameters. (auth)

3540 MANY-GROUP CROSS SECTIONS OF HYDROGEN IN P_n APPROXIMATIONS. Lebedeva, M. I. pp 257-338 of Byulleten' Informatsionnogo Tsentra po Yadernym Dannym. /Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). (In Russian).

Systems of multigroup hydrogen cross sections are presented as a result of P_{12} approximations, and may be used both in neutron spectra calculations in a reactor and in solving albedo problems. An Algol-60 program furnishes the system of hydrogen constants and provides data on hydrogen-containing media. A table of values is reproduced for each nth moment of elastic cross sections computed, and tables include the 26-group system, the 23-group system, the 21-group system, and the 18-group system. (K.S.W.)

3541 PROMINENT TWO-BODY EFFECTS IN THE PROCESSES p(^{3}He,pd)p AND d(d,pd)n. Wielinga, B. J. (Inst. for Nuclear Physics Research, Amsterdam); Ijpenberg, A. D.; Mulder, K.; van Dantzig, R.; Slaus, I. Phys. Rev. Lett.; 27: No. 18, 1229-32(1 Nov 1971).

A coincidence study of three-body breakup of the ^{3}He + p and the d + d system was made with the multidetector system BOL at 69 MeV ^{3}He energy and 26 MeV deuteron energy. Strong contributions from quasi two-body reactions (final-state interaction and quasi-free scattering) are found. The Watson–Migdal theory and the plane-wave impulse-approximation model do not consistently explain the data. The discrepancies are particularly striking where different two-body mechanisms overlap. (auth)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 3534, 3554, 3555, 3562, 3567, 3577, 3587, 3593, 3603–3606, 3638, and 3646.

3542 (FRNC-TH-42) STUDY OF ΔT = 1 TRANSITIONS: NUCLEON-^{6}Li REACTIONS AT 14 MeV. Merchez, Fernand (Grenoble Univ. (France). Faculte des Sciences). 1970. 148p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The techniques used in carrying out (n,n'), (p,p') and (n,p) experiments with ^{6}Li and the results obtained are described. The differential and absolute cross sections were measured for the elastic and inelastic scattering [Q = −2.18 MeV(3$^+$) and Q = 3.56 MeV (0$^+$)] of 14 MeV neutrons and protons by ^{6}Li and also for the ^{6}Li(n,p)^{6}He and ^{6}Li(n,p)^{6}He* (Q = −1.80 MeV 2$^+$) reactions. The results concerning the ΔT = 1 transitions are compared to those of the ^{6}Li(p,n)^{6}Be reaction at 14 MeV; the results for all the transitions are then compared with those obtained at a higher energy. It is shown that in the charge independence hypothesis the various ΔT transitions can be simultaneously analyzed. This analysis was first made using the ^{6}Li[(α + d) and (^{5}He + p)] cluster model using a simple nucleon–nucleon or nucleon core interaction. Eventually the microscopic interaction formalism was applied, the effect of the parameters which influence the theoretical result being emphasized. (France)

3543 (ITF-71-53-P) ELECTRICAL EXCITATION OF SOME LOW-LYING LEVELS OF 1p-SHELL NUCLEI. Tartakovskii, V. K.; Fursaev, A. V.; Shpinar, L. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 23p. (In Russian). Dep. NTIS (U. S. Sales Only).

The influence of the coupling scheme in light nuclei on the behavior of the electroexcitation cross sections of some low-lying levels is studied. In the transition from ls coupling to an intermediate one the dependence of differential cross sections on electron scattering angles changes only the values in C2, E2 and M3 transitions and changes considerably the form in the M1 transition. It is shown that in some cases the angular dependence of scattering electrons is very sensitive to small changes of the nuclear coupling scheme. (auth)

3544 (JINR-E4-5985) PARTIAL TRANSITIONS IN MUON CAPTURE BY COMPLEX NUCLEI. I. THE CAPTURE RATE. Bukhvostov, A. P.; Chatrchjan, A. M.; Dogotar, G. E.; Eramzhyan, R. A.; Oziewicz, Z.; Popov, N. P.; Vartanjan, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 18p. Dep. NTIS (U. S. Sales Only).

The partial capture rates in muon capture by some light nuclei (^{9}Be, ^{10}B, ^{12}C, ^{14}N, ^{15}N and ^{19}F) are calculated. The dependence of capture rates on nuclear structure is investigated. The possibility of deriving muon-nucleon coupling constants from data on light nuclei is discussed. (auth)

3545 (JINR–P2-5939) CLUSTER STRUCTURE OF LIGHT NUCLEI AND LONG-RANGE α-PARTICLES. Abdinov, O. B.; Barashenkov, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

It has been shown that α-particles with the energies T ≥ 32 MeV, observed in the bombardment of carbon with the 660-MeV protons, can be interpreted as α-clusters knocked on from the nuclei in the process of the intranuclear cascade development. Studying of their properties can give valuable information about the cluster structure of light nuclei. (auth)

3546 (LYCEN–7124) $(\alpha,2\alpha)$ REACTION ON ^{9}Be AT 42.8 AND 49.2 MeV AND ON ^{16}O AT 49.2 AND 52.5 MeV. Guichard, A.; Chevallier, M.; Gaillard, P.; Grossiord, J.-Y.; Gusakow, M.; Pizzi, J.-R.; Ruhla, C. (Lyon Univ. (France). Institut de Physique Nucleaire). May 1971. 14p. Dep. NTIS (U. S. Sales Only).

The $(\alpha,2\alpha)$ reaction with ^{9}Be at 42.8 and 49.2 MeV, and with ^{16}O at 46 and 52.5 MeV was studied in order to test the validity of the impulse approximation. The experimental data are consistent with this approximation, although much better agreement was obtained in the case of this same reaction with ^{6}Li. (auth) (France)

3547 (NP–18991) ALPHA-PARTICLE UNSTABLE STATES IN ^{12}C. Fawzi, M. A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). May 1971. 59p. Dep. NTIS (U. S. Sales Only).

Alpha particle unstable states in ^{12}C were investigated using the three reactions ^{14}N(d,α')^{12}C, ^{14}N(d,$\alpha'\alpha$)^{8}Be and ^{12}C(α,α')^{12}C. Excitation cross sections and angular distributions were measured for the reactions ^{14}N(d,α') at 52 MeV and ^{12}C(α,α') at 90 MeV. For a few angle pairs the α-decay of excited states in ^{12}C were observed in a ^{14}N(d,$\alpha'\alpha$) correlation measurement. The reactions selectively excite only T = 0 states. A previously undetected level with a large α-decay width (Γ = 1.2 MeV) was observed at 15.62 MeV excitation. This level shows up clearly in both reactions and is further distinguished from the nearby 14.08 state in the correlation measurement because of the distinctly different energy distributions of the decay products. On the basis of α particle angular distributions the 15.62-MeV level was assigned spin and parity 4^{+} and the level at 14.08 was assigned 3^{-}. The latter differs from the value suggested by earlier work. Comparison with DWBA calculations indicates that angular distributions of all other prominent levels are in agreement with their earlier assignments. Two levels at 19.20 and 20.30 MeV (both $\Gamma \approx 0.4$ MeV) and three further levels at 21.81, 22.7 and 24.24 MeV also decay predominantly by α-emission. (auth)

3548 TRANSFER REACTIONS BELOW THE COULOMB BARRIER. Barker, P. H.; Cockburn, P. M.; Huber, A.; (and others) (Laboratorium fuer Kernphysik, Zurich). Ann. Phys. (N. Y.); 66: No. 2, 705-20(Aug 1971).

Heavy-ion one-neutron-transfer reactions were investigated at energies below the Coulomb barrier. Through the use of a DWBA treatment, products of neutron spectroscopic factors are derived and compared with nuclear-model predictions. (auth)

3549 INELASTIC PROTON SCATTERING FROM ^{16}O AT BOMBARDING ENERGIES FROM 24.6 TO 40.1 MeV. Bayer, Douglas. East Lansing, Mich.; Michigan State Univ. (1970). 110p. University Microfilms Order No. 71-18,165.

Thesis.

Proton inelastic scattering from ^{16}O was measured at bombarding energies of 24.6, 29.8, 33.5, 36.6, and 40.1 MeV. Angular distributions were obtained from 10° to 100° for the doublet of states at 6.05 MeV (0^{+}) and 6.13 MeV (3^{-}) and the doublet of states at 6.92 MeV (2^{+}) and 7.12 MeV (1^{-}). The cross sections for exciting these four states were analyzed using realistic nucleon–nucleon forces. The nuclear structure information necessary to construct form factors suitable for DWM calculations was obtained by fitting the available inelastic electron scattering data. The long range part of the Kallio–Kolltveit interaction provided an adequate description of the magnitude of the cross sections. The shapes of the calculated differential were insensitive to the interaction used, with all interactions adequate to describe observed shapes. A macroscopic collective-model analysis of the data was also undertaken. The deformations were found to exhibit little energy dependence from 29.8 to 40.1 MeV, and were in good agreement with electromagnetic-transition data. (Diss. Abstr. Int., B)

3550 ANOMALIES NEAR THRESHOLD IN PROTON INTERACTIONS WITH ^{9}Be NUCLEI AT 2.06 MeV. Gopych, P. M.; Salatskii, V. I.; Sizov, I. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 1, 247-8(Jul 1971). (In Russian).

Previous authors had obtained inconsistent results in elastic scattering cross section measurements in the ^{9}Be(p,n)^{9}B reaction in the neighborhood of the threshold (2.06 MeV). The work was repeated between 1.97 and 2.18 MeV. An accelerated proton beam was passed through a focussing quadropole lens before impinging on thin Be foils. Within the limits of experimental error (2 to 3%) anomalies were not detected. (K.S.W.)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 3534, 3577, 3585, 3587, 3593, 3596, 3602–3606, 3638, 3646, 3653, and 3812.

3551 (AWRE-O-41/71) (n,n'γ) REACTIONS IN NATURAL CHROMIUM. Coles, R. E. (Atomic Weapons Research Establishment, Aldermaston (England)). Jul 1971. 19p. Dep. NTIS (U. S. Sales Only). UK 15p.

The AWRE 6-MV Van de Graaff accelerator was used to study (n,n'γ) reactions in natural chromium for incident neutrons in the energy range 0.55 to 3.85 MeV. Lithium-drifted germanium spectrometers were used to detect de-excitation γ-rays following inelastic scattering from samples in ring geometry. In all, twelve transitions were observed and relative differential cross sections, at a mean angle of 100°, are presented as a function of incident neutron energy, together with improved values of γ-ray and level energies. (auth)

3552 (BNL-tr-443) RADIAL VARIATIONS OF THE CHARGE DENSITIES AND DIRECT ANALYSIS OF ELASTIC SCATTERING OF ELECTRONS BY NUCLEI. Pol, Yu. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report JINR-P3-3936. 18p. Dep. NTIS.

A method of direct analysis of the data on elastic scattering of electrons by nuclei is proposed. This method is based on the work of V. K. Luk'yanov et. al, (Yadernaya Fizika 9, 349 (1969) in which an analytic expression was obtained in the high-energy approximation for the scattering cross section of electrons by nuclei with arbitrary Fermi-like charge–density distribution. The results of the direct analysis of data on elastic scattering of electrons by calcium-40 at 250 MeV and by calcium-40 and -48 at 750 MeV are considered. (J.F.P.)

3553 (IFA-FN-38) REEXAMINATION OF TWO-AXIS SPECTROMETER NEUTRON CRITICAL SCATTERING DATA FOR IRON. Popovici, M. (Institutul de Fizica Atomica, Bucharest (Romania)). 1970. 7p. Dep. NTIS (U. S. Sales Only).

The behavior of the wavelength-dependent susceptibility of iron is reanalyzed by taking into account new data on the spin dynamics in the critical region. (auth)

3554 TWO BODY CONTRIBUTION TO THE EFFECTIVE RADIUS OPERATOR. Samick, Larry (Rutgers–The State Univ., New Brunswick, N. J.). Ann. Phys. (N. Y.); 66: No. 2, 784-9(Aug 1971).

A well-known j–j coupling formula for the binding energies of nuclei, which was obtained and used very successfully by the "Israeli group," seems also to apply to nuclear charge radii. This suggests that the effective radius operator has not only a one-body part but also a two-body part. (auth)

3555 REMARKS ON MUONIC ATOMS OF NUCLEAR ISOMERS. Huffman, A. H. (Brookhaven National Lab., Upton, N. Y. California Inst. of Tech., Pasadena); Goldhaber, Maurice. Ann. Phys. (N. Y.); 66: No. 1, 366-72(Jul 1971).

Internal Compton scattering in a muonic atom with an excited nucleus is discussed as an alternative method for the nucleus to make a $0 \rightarrow 0$ transition. This process is extremely slow for ^{72}Ge, whereas, in a muonic atom of excited ^{16}O, internal conversion of the muon is the fastest decay process. (auth)

3556 EVIDENCE FOR QUARTET STRUCTURES IN THE NICKEL REGION. Faraggi, H.; Jaffrin, A.; Lemarie, M.-C.; (and others) (CEN, Saclay, France). Ann. Phys. (N. Y.); 66: No. 2, 905-26(Aug 1971).

It has been found that a small number of levels in several nickel and zinc doubly even isotopes are strongly and selectively excited at low energies by the (^{16}O, ^{12}C) α-transfer direct reaction performed on iron and nickel targets near the Coulomb barrier. The behavior of these states, together with calculations performed in the stretch scheme, strongly suggest that they involve a quartet structure, namely, two protons and two neutrons in a highly symmetric configuration. The α-cluster model, which was successful in light nuclei, has now found a general and natural extension in medium-weight nuclei in terms of quartet states; this result expresses the importance of four-nucleon correlations in nuclear structure. (auth)

3557 DISCUSSION OF THE ROLE OF DISPERSION EFFECTS ON ISOTOPIC CHARGE DENSITY VARIATIONS. Wall, N. S. (Univ. of Maryland, College Park). Contract AT(40-1)-3491. Ann. Phys. (N. Y.); 66: No. 2, 790-7(Aug 1971).

The role of dispersion correction is qualitatively studied in isotopic comparison experiments. The correction to elastic electron scattering for electrons of order 100 MeV from three isotopes of titanium is estimated using a code due to Rawitscher. The dispersion correction is found to produce variations in the ratio of the cross sections of nearby isotopes of a magnitude sufficient to cast doubt on the magnitude of the variations in charge-density parameters. (auth)

3558 MEASUREMENTS AND MODELS OF THE LEVEL STRUCTURE OF ^{42}Sc. Sherr, R. (Princeton Univ., N. J.); Bhatia, T. S.; Cline, D.; Schwartz, J. J. Ann. Phys. (N. Y.); 66: No. 2, 548-77(Aug 1971).

The levels of ^{42}Sc were investigated by means of the reaction ^{42}Ca(^{3}He,t)^{42}Sc at 26 MeV with an energy resolution of 9 keV up to an excitation energy of 4.0 MeV. Possible spins, parities and isospins were assigned to many levels. Difficulties in making parity assignments on the basis of angular distributions are discussed. A level scheme for ^{42}Sc is proposed on the basis of a comparison of these results with data from experiments using other reactions. Below 4.0 MeV there are at least 44 levels compared with 9 levels obtained in shell model calculations of the $(1f2p)^2$ configurations. To account for the many additional states, a weak-coupling model for 4-particle–2-hole states is invoked which is in good qualitative agreement with shell-model calculations of similar configurations. Arguments for the existence of at least 8 negative-parity states are presented, although only one level, at most, could be assigned negative parity experimentally. (auth)

3559 MANY-PARTICLE ISOMERIC STATES AS SOURCE OF PROTON AND NEUTRON RADIO-ACTIVITY. Peker, L. K. (Metrological Inst., Leningrad); Volmyanskii, E. I.; Bunakov, V. E.; Ogloblin, S. G. Phys. Lett.; 36B: No. 6, 547-9(18 Oct 1971).

Specific features of many-particle isomeric states with large spin values ($I \geq 17/2$) are considered in a search for proton and neutron radioactivities. A list of nuclei, which might serve as sources of this radioactivity, is given. The characteristic times τ_p and τ_a are calculated. (auth)

3560 ISOSPIN STRUCTURE OF THE GIANT DIPOLE RESONANCE OF THE EVEN ISOTOPES OF NICKEL: A MICROSCOPIC CALCULATION BASED ON THE EQUATIONS-OF-MOTION FORMALISM. Ngo-Trong, C.; Rowe, D. J. (Univ. of Toronto). Phys. Lett.; 36B: No. 6, 553-6(18 Oct 1971).

The electric dipole excitations for the even isotopes of nickel are calculated in a particle–hole approximation derived from the equations-of-motion formalism. Isospin is assumed to be a good quantum number. The ground states are taken from a preliminary shell-model calculation. The results are in remarkable agreement with experiment. (auth)

3561 RECOMMENDED PARAMETERS OF THE OPTICAL POTENTIAL FOR DESCRIBING ELASTIC NEUTRON SCATTERING BY YTTRIUM. Popov, V. I.; Trykova, V. I.; Cherkasov, V. I. pp 114-15 of Byulleten' Informatsionnogo Tsentra po Yadernym Dannym. /Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). (In Russian).

Optical-potential parameters recommended for a description of the angular distribution of elastically scattered neutrons by yttrium nuclei are tabulated over the initial energy range from 2 to 15 MeV. The parameters were obtained with the aid of a computer-programmed automatic search of the experimental data of various authors. (K.S.W.)

3562 ELASTIC NEUTRON SCATTERING. Bazazyants, N. O.; Popov, V. I. pp 137-57 of Byulleten' Informatsionnogo Tsentra po Yadernym Dannym. /Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). (In Russian).

Experimental data, published during 1967–68, on the angular distribution of elastically scattered neutrons comprise this article, which forms a supplement to the corresponding material that appeared in earlier issues of this Bulletin. (17 references.) (K.S.W.)

3563 NUCLEON DISTRIBUTION IN THE NUCLEI $^{50\ 52\ 54}$Cr, $^{54\ 56}$Fe, AND $^{58\ 60\ 62\ 64}$Ni. Shilyaev, B. A.; Shlyakhov, N. A.; Golovnya, V. Ya.; Klyucharev, A. P. (Physical-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.); 13: No. 12, 473-5 (20 Jun 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 12, 668-71(20 Jun 1971).

The rms radii of the neutron and nuclear-matter distributions from proton elastic scattering by even Cr, Fe, and Ni isotopes are obtained by an analysis based on the reformulated optical model. The rms radii of the charge distribution obtained from electron scattering by Ni are also given, and the change in the parameters of the charge and nuclear-matter distributions with A is compared. The results exhibit the characteristic features of the relation between the pair correlation and the self-consistent field. The general behavior of the rms distribution radii of the nuclear matter with changing mass number, which agrees with Hartree–Fock–Bogolyubov calculations of nuclear structure, offers evidence of the propagation of the neutrons beyond the limits of the proton distribution. (R.W.R.)

3564 NEAR-THRESHOLD SINGULARITIES OF THE YIELD OF DIRECT PHOTONUCLEAR REACTIONS. Ratner, B. S. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 13: No. 11, 447-9(5 Jun 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 11, 628-31(5 Jun 1971).

A bremsstrahlung beam was used to measure excitation functions for the reaction ^{64}Ni(γ,p)^{63}Co at 15.0 to 17.0 MeV and the reaction ^{53}Cr(γ,p)^{52}V 12.2 to 14.0 MeV. The results demonstrate that the yield curve for the reaction ^{64}Ni(γ,p)^{63}Co has, in the region close to the reaction threshold, not only a rising part but also a part consisting of individual narrow (~1 keV) peaks. To explain this result it is proposed that, in addition to the bremsstrahlung spectrum, there exists a narrow gamma line with energy close to the kinetic energy of the accelerated electrons and intensity equal to the intensity of the bremsstrahlung spectrum in the region 0.2 to 0.4 MeV from the end point. This line can appear only in those cases when the cross section near the threshold consists of individual narrow peaks. Apparently, the large difference between the densities of the single-particle levels of ^{64}Ni and ^{53}Cr causes the unusual structure of the yield curve to be observed only for the former. The appreciable shift of the start of the yield curve for the reaction ^{64}Ni(γ,p)^{63}Co relative to threshold, as compared with that for the reaction ^{53}Cr(γ,p)^{52}V, is apparently due to the same factor. (R.W.R.)

3565 ACTIVATION CROSS SECTIONS FOR PROTON-INDUCED REACTIONS ON CALCIUM ISOTOPES UP TO 5.6 MeV. de Waal, Tielman J.; Peisach, Max; Pretorius, Rene (Southern Universities, Faure, S. Afr.). J. Inorg. Nucl. Chem.; 33: No. 9, 2783-9(Sep 1971).

Calcium fluoride, of natural isotopic composition and isotopically enriched, was activated with proton beams up to 5.6 MeV using a Van de Graaff accelerator. Activation cross sections were determined by γ-ray spectrometry for the reactions: ^{43}Ca(p,n)^{43}Sc; ^{44}Ca(p,n)^{44}Sc and ^{48}Ca(p,n)^{48}Sc. The relative accuracy of the excitation functions is ±5% except for the reaction ^{43}Ca(p,n)^{43}Sc, where the accuracy is ±8%. (auth) (UK)

3566 VARIATION OF THE ^{78}As ISOMERIC CROSS SECTION RATIO WITH NEUTRON ENERGY. Cox, A. J.; De Kock, J. J. J. (Univ. of Aston, Birmingham, Eng.). J. Inorg. Nucl. Chem.; 33: No. 9, 3171-3(Sep 1971).

It is postulated that the isomeric state of ^{78}As decays predominantly by β emission. The variation of the isomeric cross section ratio with incident neutron energy is given, from which it is shown that the fastest rise is in the region 0 to 3 MeV, which is the most useful region for reactor studies. For the neutron source used (3×10^6 n/sec) it was found that neutron energies can be measured to an accuracy of ±5%. Thus there is an isomeric state in ^{78}As which is likely to be of use measuring neutron energies in the range 0 to 3 MeV. (UK)

3567 INELASTIC SCATTERING CROSS SECTIONS OF ^{19}F, ^{58,60,62}Ni, AND ^{59}Co. Rogers, V. C. (Lowell Technological Inst., Mass.); Beghian, L. E.; Clikeman, F. M. Trans. Amer. Nucl. Soc.; 14: No. 2, 806-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3568 EVALUATION OF ^{23}Na NEUTRON DATA FOR THE ENDF/B VERSION III FILE. Paik, N. C.; Pitterle, T. A. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 814-16(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3569 ASSESSMENT OF THE ENDF/B-II (n,2n) DATA FOR ^{63}Cu BASED ON A CONSISTENT EVAPORATION MODEL. Henryson II, H. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 816(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3570 LOW-ENERGY CROSS SECTION FOR ^{54}Fe(n,p)^{54}Mn AND OTHER EXOERGIC REACTIONS. McElroy, W. N.; Simons, R. L.; Ulseth, J. A.; Kellogg, L. S. Trans. Amer. Nucl. Soc.; 14: No. 2, 896-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3571 DISCRETE AND CONTINUUM GAMMA-RAY PRODUCTION CROSS SECTIONS FOR Fe AND Al FROM 0.9 TO 17 MeV. Orphan, V. J.; Hoot, C. G.; John, Joseph (Gulf Radiation Tech., San Diego, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 897(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3572 CALCULATED ANGULAR DISTRIBUTION CORRECTIONS FOR (n,xγ) MEASUREMENTS ON THE GRT-LINAC. Rogers, V. C. (Brigham Young Univ., Provo, Utah); Hedengren, D. C.; Orphan, V. J.; Hoot, C. G. Trans. Amer. Nucl. Soc.; 14: No. 2, 897-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3573 HIGH-ENERGY NEUTRON CAPTURE GAMMA-RAY PRODUCTION CROSS SECTION FOR ^{28}Si. Takahashi, Hiroshi (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 899-900(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

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Refer also to abstracts 3166, 3534, 3559, 3562, 3638, 3656, 3657, 3660, and 4061.

3574 (AAEC/TM-595) TRAJECTORY CALCULATIONS FOR LIGHT PARTICLES EMITTED IN SPONTANEOUS TERNARY FISSION. Musgrove, A. R. de L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jun 1971. 16p. Dep. NTIS (U. S. Sales Only).

Trajectory calculations have been carried out for ^{252}Cf fission accompanied by ^{1}H, ^{2}H, ^{3}H, ^{6}He and ^{8}He particles. Initial dynamic variables of the fissioning system were found which gave satisfactory fits to the observed energy spectra. It was found that the heavy fragment separation at scission increases as the mass of the third particle decreases. The energy cost in releasing each of the particles was calculated and three factors influencing the fractional yields were identified. (auth)

3575 (ANL-7830) DISCREPANCIES AND POSSIBLE ADJUSTMENTS IN THE 2200-m/s FISSION PARAMETERS. De Volpi, A. (Argonne National Lab., Ill.). Jun 1971. Contract W-31-109-eng-38. 47p. Dep. NTIS.

The status of 2200-m/s fission constants was reviewed, focused mainly on ^{235}U, ^{239}Pu, and ^{233}U. The most recent work in this field has been by the IAEA published in 1969. Depending very much on a partially subjective view toward experimental credibility, a significantly different set of parameters can be developed. The points of departure are in acceptance by the reviewer of the more recent low measurements of the ^{233}U and ^{234}U half-lives and of reduced down-weighting of some absolute measurements of $\nu(^{252}\text{Cf})$ which have been the object of extensive verification procedures. This results in 1% lower ν values for the fissile isotopes. In addition, some reduction in η values are experimentally justified. The half-life revisions augment evidence that the fission cross sections for ^{233}U and ^{235}U should be higher than the IAEA average. As a result of this study, an adjusted set of fission parameters is generated with substantive support from the revised experimental input data. A uniform constraint of constant product $\nu\sigma_f = \eta\sigma_a$ is applied, which makes most integral experiments insensitive to the modifications. Both ^{233}U and ^{239}Pu sets have additional ambiguities due to inadequate input data, indicating possible reductions in the constraining product. (auth)

3576 (FRNC-TH-58) STUDY OF (^{3}He,α) REACTIONS WITH NUCLEI POSSESSING 52 NEUTRONS. Charles, Pierre (Paris Univ., Orsay (France). Faculte des Sciences). 1970. 75p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The (^{3}He,α) reaction mechanism was studied in detail and the conditions under which the distorted wave Born approximation may be used to analyze the angular distributions were determined. The (^{3}He,α) reaction is often presented as a surface reaction, but the interior of the nucleus can play a decisive role and the validity of certain approximations inherent in the DWBA are thus questionable. It was possible to demonstrate that in the cases for which the experimental results do not agree with theoretical predictions, a considerable part of the transition amplitude arises from the interior of the nucleus. These conclusions were used in analyzing (^{3}He,α) reactions with N = 52 nuclei (^{92}Zr, ^{95}Nb and ^{94}Mo). The spectroscopic results obtained, principally the establishment of 1 particle and 2 particle−1 hole states confirm that it is possible to account for the properties of most of the weakly excited levels in the ^{91}Zr, ^{92}Nb and ^{93}Mo nuclei by simply considering a restricted number of configurations of the shell model. (France)

3577 (FRNC-TH-81) ON-LINE MASS SPECTROMETRY OF EXOTIC LIGHT NUCLEI PRODUCED IN HIGH-ENERGY REACTIONS. Thibault-Philippe, Catherine (Paris Univ., Orsay (France). Faculte des Sciences). 1971. 120p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

On-line mass spectrometry was used to measure the cross sections for the production of sodium isotopes in high energy nuclear reactions; certain new exotic nuclei were identified. All the cross section distributions for the different isotopes were measured using various targets (68 values); five new sodium isotopes were identified, 6 radioactive half-lives were measured, and an unknown β spectrum observed. An even−odd effect, and a large disymmetry in the distribution of the cross sections involved, in the production of the various sodium isotopes, were observed. Phase space considerations were important in interpreting the mechanisms envisaged. These measurements, used in conjunction with other cross section measurements concerning light nuclei, led to the establishment of a general systematics for the cross sections involved in the production of light nuclei in nuclear reactions induced by protons with energies between 3 and 30 GeV. The new information obtained on light exotic nuclei facilitated the analysis of the methods for calculating the nuclear masses and the more detailed study of certain characteristics such as spins and ground states. In this way it was shown that among the still unknown very light nuclei, ^{17}B is bound and identifiable by electronic methods. (auth)

3578 (FRNC-TH-92) MEASUREMENT OF FISSION YIELDS USING ON-LINE ISOTOPE SEPARATION. Brissot, Roger (Grenoble Univ. (France)). 1971. 64p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

An on-line separation process is described. A direct junction between the fissile material target and the separator ion source was effected. The fission phenomenon and its consequences are recalled, and the apparatus used described. A discussion is given on the path across the installation assumed by the radioactive atoms produced, the various corrections, which must be made to the experimental data, being considered. These relate to gaseous products such as ^{137}Xe, ^{138}Xe, ^{139}Xe, ^{140}Xe and ^{87}Kr, ^{88}Kr, ^{89}Kr, ^{90}Kr, ^{91}Kr, produced by fission with 14-MeV neutrons of ^{238}U, ^{235}U and ^{232}Th isotopes. The cumulative rare gas yields were thus measured. (France)

3579 (IEA-221) DETERMINATION OF THE DECAY CONSTANT FOR SPONTANEOUS FISSION OF ^{238}U. Renner, C.; Leme, M. P. T.; Cattani, M. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Sep 1970. 10p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

The fission track method was used to determine the decay constant λ_F for spontaneous fission of ^{238}U. This method requires the following measurements: (a) number of spontaneous fission tracks of ^{238}U; (b) number of induced fission tracks of ^{235}U due to thermal neutrons and (c) the thermal neutron flux. The direct neutron flux determination is avoided by measuring instead the activity induced by this flux in a material with cross section obeying the 1/v law. Samples of natural uranium in contact with mica sheets remained sealed about four years. The decay constant was found to be $\lambda_F = (7.30 \pm 0.16)10^{-17}\text{y}^{-1}$. (auth)

3580 (INR-1307) NUCLEAR STRUCTURE STUDIES WITH ON-LINE ISOTOPE SEPARATION METHODS. II. COLLECTIVE STATES IN EVEN NUCLEI IN W-Pt REGION. Jastrzebski, Jerzy (Institute of Nuclear Research, Warsaw (Poland)). 1971. 101p. (In Polish). Dep. NTIS (U. S. Sales Only).

A compilation of the existing experimental data on the collective excited states in even tungsten, osmium and platinum nuclei is presented. The excitation energies, reduced transition probabilities, quadrupole moments and deformations are discussed. The recent results obtained by on-line nuclear spectroscopy were extensively used in this compilation. For heavier nuclei of the considered elements the experimental data are compared with a pairing + quadrupole model calculations of Kumar and Baranger. (auth)

3581 (JAERI-1211) DECAY ANALYSIS OF SOME FISSION PRODUCT NUCLIDES WITH MEDIUM HALF-LIVES. Baba, Sumiko; Baba, Hiroshi; Umezawa, Hirokazu; Suzuki, Toshio; Sato, Tadashi (Japan Atomic Energy Research Inst., Tokyo). Jul 1971. 31p. Dep. NTIS (U. S. Sales Only).

The half-lives of 22 fission product nuclides were measured. Their decay curves were obtained by the β-ray countings with end-window type gas flow proportional counters, and were analyzed with a non-linear least squares fitting programme using the IBM-7044 computer. The resulting half-life values are listed with those previously reported. (auth)

3582 (JINR-E6-5989) THREE-QUASIPARTICLE EXCITATIONS IN ^{205}At. Hagemann, U.; Neubert, W.; Schulze, W.; Stary,

F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 17p. Dep. NTIS (U. S. Sales Only).

In the reaction $^{197}Au(^{12}C,4n)^{205}At$ an isomeric state with a half-life $T_{\frac{1}{2}} = 110 \pm 25$ ns was observed, which is ascribed to the $21/2^-$ state of the $p(h_{9/2})^3$ multiplet. Compared to the corresponding nucleus ^{211}At this multiplet is not well developed, because the unfilled neutron shell causes a configuration mixing with the two-neutron states. (auth)

3583 (JINR–E7-5917) NEW ISOTOPES: $^{29,30}Mg$, $^{31,32,33}Al$, $^{33,34,35,36}Si$, $^{35,36,37,38}P$, $^{39,40}S$ AND $^{41,42}Cl$, PRODUCED IN BOMBARDMENT OF A ^{232}Th TARGET WITH 290 MeV ^{40}Ar IONS. Artyukh, A. G.; Avdeichikov, V. V.; Gridnev, G. F.; Mikheev, V. L.; Volkov, V. V.; Wilczynski, J. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 10p. Dep. NTIS (U. S. Sales Only).

Seventeen new nuclides, $^{29,30}Mg$, $^{31,32,33}Al$, $^{33,34,35,36}Si$, $^{35,36,37,38}P$, $^{39,40}S$, and $^{41,42}Cl$, together with other, already known nuclides, were detected and identified in bombardment of a ^{232}Th target with 290-MeV ^{40}Ar ions. A charged-particle identification system combining magnetic analysis and the $\Delta E-E$ technique was used. The resolving power of the system was good enough to resolve isotopes of argon. (auth)

3584 (LB/G–3039) CALCULATIONS OF ENERGY SPECTRA OF FISSION FRAGMENTS AND VALUES OF $\bar{\nu}$ FOR TARGETS OF DIFFERENT THICKNESS. Dermendzhiev, E.; Panteleev, Ts. (Joint Inst. for Nuclear Research, Dubna (USSR)). Lab. of Neutron Physics). Translated by J. B. Barbour (Atomic Energy Research Establishment, Harwell, Eng.), from report JINR–P3-5081. 14p. Dep. NTIS (U. S. Sales Only).

Calculations are made of the energy spectra of fission fragments and the values of $\bar{\nu}$ over the fragment spectra for targets of different thickness. The results of the calculations, together with the data from the paper by S. Bochvarov et al. [Physics and Chemistry of Fission (IAEA, Vienna, 1969) p. 465], give the value 0.65 MeV for the change in the energy of the fragments at ^{235}U resonances. It is shown that allowance for the instrumental effect connected with the fragment yields from relatively thick targets does not eliminate the contradiction between the Dubna and USA data on $\bar{\nu}$ at ^{239}Pu resonances. (auth)

3585 (LB/G–3049) MEASUREMENT OF THE HALF-LIVES OF ^{60}Co, ^{137}Cs, AND ^{133}Ba. Walz, K. F.; Weiss, H. M. Translated by W. G. Stripp (Atomic Energy Research Establishment, Harwell, Eng.), from Z. Naturforsch., A; 25: No. 6, 921-7(1970). 12p. Dep. NTIS (U. S. Sales Only).

The half-lives of cobalt-60, cesium-137, and barium-133 were found from measurements of the activities of samples against the activity of a radium-226 standard using an ionization chamber. The results were obtained from a least-squares fit and corrections for the decay of radium-226. The half-life for cobalt-60 was found to be 5.2719 ± 0.0011 years; that for barium-133 was 10.352 ± 0.040 years; and that for cesium-137 was 29.901 ± 0.045 years. (J.F.P.)

3586 (MLM–1845(DR)) SPONTANEOUS FISSION HALF-LIVES OF ^{244}Cm AND ^{252}Cf. Hastings, J. D.; Strohm, W. W. (Mound Lab., Miamisburg, Ohio). 1 Oct 1971. Contract AT-33-1-Gen-53. 9p. Dep. NTIS.

The spontaneous fission half-lives of ^{244}Cm and ^{252}Cf have been measured and found to be $(1.343 \pm 0.011) \times 10^7$ yr and 85.2 ± 0.5 yr, respectively. The spontaneous fission fragments were counted with silicon surface barrier detectors using commercially available electronic equipment. The spontaneous fission half-lives were calculated by comparing the alpha-to-fission ratio with alpha half-lives of 18.099 yr for ^{244}Cm and 2.705 yr for ^{252}Cf. (auth)

3587 (NP–18969) PROGRESS REPORT, 1970. (Alberta Univ., Edmonton. Nuclear Research Centre). 70p. Dep. NTIS (U. S. Sales Only).

The research and development program is summarized including charged particle studies, gamma ray studies, pulsed beam experiments, theoretical studies, TRIUMF, and computers. Personnel and publications are listed. (W.H.K.)

3588 (NP–19009) LEVELS OF ^{165}Ho. STUDY OF CORIOLIS COUPLING BETWEEN BANDS $\frac{1}{2}+[411\downarrow]$ AND $\frac{3}{2}+[411\uparrow]$. Mauron, G.; Kern, J.; Huber, O. (Freiburg Univ. (West Germany). Physikalisches Institut). [1970]. 72p. (In French). Dep. NTIS (U. S. Sales Only).

The level scheme of ^{165}Ho was investigated using the β-decays of ^{165}Dy (2.35 h) and ^{165m}Dy (75 s). With the help of a Ge(Li) detector a total of 54 and 12 transitions respectively were observed. In the ground state decay 22 low energy conversion lines were resolved in the Fribourg double focusing magnetic spectrometer. With these data it was possible to obtain the multipolarities of several transitions and to construct a scheme of the ^{165}Ho levels having 7 rotational bands. The precision in the energy level determination varies between 3 and 90 eV. Deviation of the simple rotational prediction in the $[411\downarrow]$ and $[411\uparrow]$ bands could be satisfactorily explained by introducing a Coriolis coupling. The wave functions so obtained are shown to explain very well the observed γ branching ratios and multipolarity mixing ratios. The other bands are discussed in terms of the Nilsson model. (auth)

3589 (ORNL–4730) CURRENT NUCLEAR LEVEL SCHEMES: A = 118 TO 139. Horen, D. J. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 271p. Dep. NTIS.

Literature containing experimental nuclear structure data has been scanned to extract energies, spins and parities, spectroscopic factors, and lifetimes for nuclei in the mass region A = 118-139. A summary of "current" data for these nuclei is presented in the form of "ladder" diagrams and accompanying tables. These data mainly represent the conclusions of the authors cited therein and have not been thoroughly evaluated, although each contributor has made some value judgments. (auth)

3590 (RISO-M–1307) INVESTIGATION OF THE LEVEL SCHEME OF ^{158}Gd BY MEANS OF THE (n,γ)-REACTION. Baader, H. A. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jun 1971. 132p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technical Univ., Munich, Ger.

Firstly are given descriptions of mainly electronic instrumentation used for the automatic version of the curved crystal γ-spectrometer at the DR3 reactor at Risö. The second part of the work deals with a measurement of the γ-spectrum after thermal neutron capture in ^{157}Gd and the investigation of the nuclear level scheme of ^{158}Gd on the basis of these data. The energies of previously known levels were generally determined with much greater precision. Several rotational bands were expanded by until now unknown levels, and three new rotational bands were discovered. The ground state rotational band is discussed up to $I = 8^+$, the gamma vibrational band up to $I = 6^+$, the beta vibrational band and an additional till now unknown $K = 0^+$ band up to the spin 4^+. Moreover the $K = 1^-$ octupole vibrational band and the new octupole bands with $K = 0^-$ and $K = 2^-$ are described up to $I = 6^-$, $I = 5^-$ and $I = 4^-$ respectively. The rather complete observation of the transitions from these levels in connection with extensive band mixing calculations gave the possibility of clarifying the relatively strong influence of the couplings between these bands. In (p,t)-experiments recently performed at the Niels Bohr Institute Tandem accelerator the levels of the new $K = 0^+$ band discussed were not excited. This result renders the proposed interpretation of the band as a pairing vibration rather unprobable. Further investigations are necessary to clarify the nature of excitation of this band. (auth) (Denmark)

3591 STUDY OF THE 1.704 MeV 1^+ STATE IN ^{206}Pb. Metzger, F. R. (Franklin Inst., Swarthmore, Pa.). Ann. Phys. (N. Y.); 66: No. 2, 697-704(Aug 1971).

The 1.704-MeV level in ^{206}Pb was excited with electron bremsstrahlung; and the resonantly scattered radiation, observed with a 45-cm^3 Ge(Li) detector. From the scattering yield, a value $\Gamma_0^2/\Gamma = 6.2 \pm 0.6$ MeV was obtained. A self-absorption experiment gave $\Gamma_0 = 9.8 \pm 1.8$ MeV. The experimental width for the M1 transition to the ground state is approximately one-third of the width expected on the basis of the most recent shell-model calculations. It is suggested that at least part of this reduction is caused by weak components in the ^{206}Pb wave functions originating from the coupling to strong M1 excitations in ^{208}Pb. (auth)

3592 NUCLEAR SYNTHESIS IN REACTIONS WITH HEAVY IONS AND THE SEARCH FOR SUPERHEAVY ELEMENTS. Flerov, G. N. Vestn. Akad. Nauk SSSR; No. 8, 43-54(Aug 1969). (In Russian).

Nature provided man with 300 stable isotopes from which he synthesized over 1,500 more isotopes. Further new isotopes may come from new "islands" of stability, new regions of deformation, isomeric states of various types, and unusual proton/neutron ratios in nuclei, with unanticipated Coulomb and nuclear forces. A recent step in this type of synthesis was the construction of heavy-ion accelerators; and the present program consists of the synthesis of transuranium elements, the study of fission processes by heavy ions, the search for super-heavy elements in naturally occurring minerals, and the production of such elements by use of accelerated heavy ions. Accomplishments along these lines are given in some detail. The chemical properties of elements 102, 103, and 104 are studied, and present research involving nuclear reactions is described. (K.S.W.)

3593 RADIONUCLIDE DECAY SCHEMES AND NUCLEAR PARAMETERS FOR USE IN RADIATION-DOSE ESTIMATION. PART 2. Dillman, L. T. (Oak Ridge National Lab., Tenn. Ohio Wesleyan Univ., Delaware). J. Nucl. Med., Suppl.; 12: No. 4, 5-32(Mar 1970).

The prominent radiations and their intensities for 30 radionuclides from ^{11}C to ^{199}Au that are of interest in nuclear medicine are presented. (R.W.R.)

3594 NONAXIAL ROTATOR MODEL FOR NUCLEI WITH SPIN OF 7/2. Sardaryan, R. A. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 5: No. 6, 425-32(1970). (In Russian).

The nonaxial-rotator model with conservation of the projection of the external nucleon momentum on the z axis is used to describe the spectra of nuclei having the ground-state spin $^7/_2$. The calculated spectrum is compared with the experimental spectra of the nuclei ^{165}Ho, ^{177}Lu, ^{165}Dy, ^{169}Yb, ^{175}Yb, ^{167}Er, ^{169}Er, ^{171}Er, ^{177}Hf, and ^{179}Hf. (auth)

3595 INELASTIC ELECTRON SCATTERING IN THE GIANT RESONANCE REGION OF La, Ce, AND Pr. Pitthan, R.; Walcher, Th. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett.; 36B: No. 6, 563-4(18 Oct 1971).

For natural Ce, La, and Pr targets (e,e') spectra were measured for primary energies between 50 and 65 MeV and scattering angles between 93 and 165°. All three elements show broad resonances at excitation energies 9, 12, and 15 MeV. The resonance at 15 MeV is identified as the E1 giant resonance. Probable assignments for the resonances at 9 and 12 MeV are M1 and M2 (or E0), respectively. (auth)

3596 CORRELATIONS BETWEEN REDUCED NEUTRON AND RADIATIVE WIDTHS ON NEUTRON RESONANCES IN COMPOUND NUCLEI WITH ODD NUMBER OF NEUTRONS. Solov'ev, V. G. JETP Lett. (USSR) (Engl. Transl.); 14: No. 3, 129-30(5 Aug 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 3, 194-6(5 Aug 1971).

The (n,γ) reaction is regarded as a two-step process: neutron capture followed by an E1 or M1 transition. Correlations between neutron and radiative widths should take place in those cases in which the main contribution to both processes is made by the same components of the wave functions of the highly excited states. Nuclei in which large correlations are expected to result from capture of s- and p-wave neutrons are listed. (R.W.R.)

3597 SCATTERING OF NEUTRONS BY NUCLEI IN THE REGION OF NON-OVERLAPPING RESONANCES OF THE NUCLEUS. Morozov, V. M.; Zubov, Yu. G.; Lebedeva, N. S. JETP Lett. (USSR) (Engl. Transl.); 14: No. 2, 91-4(20 Jul 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 2, 137-40(20 Jul 1971).

The differential cross sections for neutron elastic scattering at (1.8 ± 0.2) MeV by ^{208}Pb were measured from 12 to 168°. Measurements were made with two neutron beams having different energy profiles. The data are analyzed by using the optical model for nonoverlapping resonances. It is concluded that the usual explanation of two interfering elastic scattering processes (shape-elastic and compound-elastic) is not applicable to the interpretation of these results, at least in the region of isolated resonances. (R.W.R.)

3598 DEPENDENCE OF 14 MeV RADIATIVE NEUTRON CAPTURE ON MASS NUMBER. Drake, D.; Bergqvist, I.; McDaniels, D. K. (Los Alamos Scientific Lab., N. Mex.). Phys. Lett.; 36B: No. 6, 557-9(18 Oct 1971).

The 14-MeV neutron radiative-capture cross section was measured for six nuclei in the mass range from A = 155 to A = 238. The integrated radiative cross sections are found to have a value near 1 mb. These results are at variance with the results obtained by the activation technique. Detailed capture γ-ray spectra were measured for one closed-shell nucleus and two deformed nuclei to illustrate their similarity in shape and magnitude. (auth)

3599 COUPLING BETWEEN INELASTIC AND PAIR TRANSFER DEGREES OF FREEDOM. THE $^{208}Pb(t,p)^{210}Pb(3^-)$ REACTION ANALYZED IN THE COPULED CHANNEL BORN APPROXIMATION. Broglia, R. A. (Univ. of Copenhagen); Landowne, S.; Paar, V.; (and others). Phys. Lett.; 36B: No. 6, 541-6(18 Oct 1971).

The reaction $^{208}Pb(t,p^{210}Pb(3^-)$ is analyzed with allowance for indirect processes. Use is made of two-body transfer spectroscopic amplitudes which include transitions proceeding through ground-state correlations induced by pairing and particle–hole collective states. Both effects are found to be important. (auth)

3600 BYULLETEN' INFORMATSIONNOGO TSENTRA PO YADERNYM DANNYM (VYPUSK PYATYI). (Bulletin of the Information Center on Nuclear Data (Fifth Edition)). Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). 356p.

Separate abstracts were prepared for each of the sixteen papers in the bulletin. (R.W.R.)

For abstracts of individual papers see: 3091, 3512, 3540, 3561, 3562, 3601–3609, 3657, and 4061.

3601 NEUTRON CROSS SECTION OF ERBIUM ISOTOPES. Vertebnyi, V. P.; Vlasov, M. F.; Kolotyi, V. V.; (and others). pp 5-19 of Byulleten' Informatsionnogo Tsentra po Yadernym Dannym. /Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). (In Russian).

Part I of this article is concerned with neutron cross-section measurement in the thermal region. Uncertainty in the isotopic composition of Er presented obstacles to establishing highly accurate values. Capture cross section measurements for the erbium isotopes were conducted with a mechanical neutron chopper in 4π geometry in the range 0.3 to 0.007 eV, by using Er_2O_3 samples. Values of the capture cross section are given for four of the six isotopes: ^{162}Er, 200 to 260 b; ^{164}Er, 0.8 to 23 b; ^{166}Er, 32 ± 2b; and ^{167}Er, 643 ± 30 b. In addition, scattering cross sections for all six isotopes are listed. Part II presents resonance parameters of Er isotopes with the pertinent data in tabular form, accompanied by a table giving calculated and experimental values of the distances between levels. (K.S.W.)

3602 INELASTIC NEUTRON SCATTERING CROSS SECTIONS WITH FIRST LEVEL EXCITATION BY EVEN–EVEN NUCLEI WITH MASS NUMBERS A = 70 TO 202. Aver'yanov, I. K.; Dzyuba, B. M. pp 20-39 of Byulleten' Informatsionnogo Tsentra po Yadernym Dannym. Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). (In Russian).

Predictions are made of the inelastic neutron scattering cross sections at energies of 7, 9, 11, and 14 MeV by sixteen even–even nuclei, ranging from $^{70}_{32}Ge$ to $^{202}_{80}Hg$. Deformation parameters, energies of the first excited state, and theoretical cross sections are tabulated. Sixteen graphs are reproduced for the sixteen isotopes mentioned, showing the angular distribution of inelastic neutron scattering with first-level excitation of the target nucleus. (K.S.W.)

3603 INELASTIC SCATTERING OF NEUTRONS. Sluchevskaya, V. M. pp 40-80 of Byulleten' Informatsionnogo Tsentra po Yadernym Dannym. /Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). (In Russian).

Results are given for the experimental measurement of the following quantities: the effective cross section for inelastic interaction, the effective cross section for inelastic scattering and the levels excited during inelastic scattering, the effective cross section for gamma-ray emission, the angular distribution from inelastic neutron and gamma-ray scattering, and the nuclear temperature in MeV. Included also are effective group cross sections for inelastic scattering by ^{233}Pa, ^{234}U, and ^{236}U. (54 references) (K.S.W.)

3604 EFFECTIVE CROSS SECTIONS OF THE (n,2n) REACTION. Sluchevskaya, V. M. pp 81-113 of Byulleten' Informatsionnogo Tsentra po Yadernym Dannym. /Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). (In Russian).

Experimental results are summarized for the effective cross sections for the (n,2n) reaction on target nuclei ranging from ^2D to ^{243}Am, and corresponding to whatever range of energies was available in the literature. Effective cross sections also are calculated or recommended on the basis of an analysis of the experimental data. (67 references.) (K.S.W.)

3605 METHOD OF INTERPOLATION, EVALUATION, AND COMPACT PRESENTATION OF INELASTIC NEUTRON SCATTERING DATA. Popov, V. I.; Trykova, V. I.; Sluchevskaya, V. M. pp 116-28 of Byulleten' Informatsionnogo Tsentra po Yadernym Dannym. /Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). (In Russian).

Four Algol-60 programs were designed to compute the spectra from inelastic neutron scattering, the group cross sections for inelastic transitions, recommended inelastic neutron cross sections, and recommended group excitation functions of nuclear levels. (K.S.W.)

3606 ALGOL PROGRAM FOR THE MONTE CARLO METHOD OF COMPUTATION OF CORRECTIONS IN EXPERIMENTAL DIFFERENTIAL CROSS SECTIONS OF ELASTIC NEUTRON SCATTERING. Popov, V. I.; Sluchevskaya, V. M.; Trykova, V. I. pp 129-36 of Byulleten' Informatsionnogo Tsentra po Yadernym Dannym. /Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). (In Russian).

Experiment simulation on an electronic computer ensures the highest accuracy for the insertion of corrections associated with finite geometry. A Monte Carlo program was compiled for correction insertion in differential elastic neutron scattering cross section measurements, allowing one to find, using known experimental results, the actual elementary process of scattering by an iteration method. (K.S.W.)

3607 EFFECTIVE RESONANCE INTEGRALS OF SOME ISOTOPES OF TRANSURANIUM ELEMENTS. Nemirovskii, P. E. pp 159-75 of Byulleten' Informatsionnogo Tsentra po Yadernym Dannym. /Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). (In Russian).

The effective resonance integrals are calculated for targets of finite thickness, i.e., of resonance absorption blocking. A sufficient quantity of data exists for the even–even nuclei ^{244}Cm, ^{240,242}Pu, and ^{236}U to proceed with calculations based upon Breit–Wigner equations. The author confines his attention to these isotopes and, in addition, the odd-Z isotopes ^{241}Am, ^{243}Am, and ^{237}Np. (K.S.W.)

3608 80th AND 21st GROUP NEUTRON ABSORPTION CROSS SECTIONS FOR ^{237}Np AND ISOTOPES OF GADOLINIUM. Zakharova, S. M. pp 189-252 of Byulleten' Informatsionnogo Tsentra po Yadernym Dannym. /Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). (In Russian).

The 80th and 21st group neutron absorption cross sections are tabulated and plottted for ^{237}Np, the naturally occurring mixture of gadolinium isotopes, and for the following specific isotopes of Gd: 155, 156, 157, and 158. Experimental data were taken from the literature up to May 1968. For ^{237}Np only the capture cross section is given; the fission cross section was published in the 1967 Bulletin of this series. The two even–odd and the two even–even Gd isotopes are discussed in terms of the Breit–Wigner theory, the resonance region, and the dependence of the cross sections on energy. The range of energy plotted in the accompanying graphs for each isotope extends from 10^{-2} to 10^{7} eV. (48 references.) (K.S.W.)

3609 26th GROUP CAPTURE CROSS SECTION OF ^{231}Pa AND ^{233}Pa. Abagyan, L. P.; Murogov, V. M. pp 253-6 of Byulleten' Informatsionnogo Tsentra po Yadernym Dannym. /Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). (In Russian).

Capture cross section measurements for ^{231}Pa and ^{233}Pa are not yet available from direct experiment. The values reported here were obtained indirectly, some being estimated in the several-keV region. Other workers calculated the 10th and 16th group constants, and still others worked with resonance parameters. (13 references.) (K.S.W.)

3610 $\beta-\gamma$ PERTURBED ANGULAR CORRELATION IN THE DECAY OF ^{124}Sb. Agnihotry, A. P.; Prasad, K. G.; Joshi, M. C. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A; 73: No. 6, 297-305(Jun 1971).

The $\beta-\gamma$ perturbed-angular-correlation technique is applied to the determination of the g factor of the 603-keV (2^+) state (τ = 8.5 psec) of ^{124}Te populated in the decay of ^{124}Sb. The activity was diffused into a thin iron foil. A small C-type electromagnet was used for polarizing the sample. Internal field acting at the tellurium nucleus in iron was used for perturbing the $\beta-\gamma$ angular correlation. The g factor extracted is $g = 0.28 \pm 0.05$. This is in good agreement with that obtained by the $\gamma-\gamma$ perturbed-angular-correlation method. (auth)

3611 PRECISE COULOMB EXCITATION B(E2) VALUES FOR FIRST 2^+ STATES OF THE ACTINIDE NUCLEI. Ford, J. L. C. Jr.; Stelson, P. H.; Bemis, C. E. Jr.; (and others) (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett.; 27: No. 18, 1232-4(1 Nov 1971).

Precise transition probabilities were measured for the first 2^+ states of ^{230,232}Th, ^{234,236,238}U, ^{238,240,242,244}Pu, ^{244,246,248}Cm, and ^{252}Cf by Coulomb excitation with 17- and 18-MeV α particles. Comparison is made with theoretical values. An excitation energy of 44.0 ± 0.5 keV was measured for the first excited level of ^{252}Cf. (auth)

3612 NATURE OF ^{135}Ba NUCLEAR LEVELS. Begzhanov, R. B.; Gladyshev, D. A.; Kobilov, O. Sh.; Radzhapov, P. S.; Sabirov, Kh. S. (Inst. Nuclear Physics, Tashkent). Izv. Akad. Nauk Arm. SSR, Fiz.; 6: No. 2, 87-92(1971). (In Russian).

The results of gamma-ray angular-correlation studies of (373 – 481) and (633–217) keV cascades in the ^{135}Ba nucleus are presented. In addition, the mean life of the 481-keV excited state was measured with the delayed-coincidence method. (auth)

3613 LOW-LYING 2^+ LEVELS IN ^{208}Pb. Kamerdzhiev, S. P.; Manakhov, L. V. Yadern. Fiz.; 13: No. 6, 1335-7(Jun 1971). (In Russian).

The energies of the low-lying 2^+ levels and E2 transition probabilities from the excited state were calculated for the ^{208}Pb nucleus. The calculations were carried out within the framework of the theory of finite Fermi systems with constants obtained from other physical phenomena. The 2^+ levels in ^{208}Pb should appear in neighboring nuclei since they are quadripole excitations of a shell. (K.S.W.)

3614 SPIN AND MAGNETIC MOMENT OF ^{151}Sm. Robertson, R. G. H. (McMaster Univ., Hamilton, Ont.); Choh, Sung Ho; Summers-Gill, R. G.; Stager, C. V. Can. J. Phys.; 49: 2227-9 (1 Sep 1971).

The spin and magnetic moment of 87-y ^{151}Sm were measured by electron paramagnetic resonance (EPR); I = $5/2$ and $|\mu^{151}(\text{corr.})|$ = 0.354(15) nuclear magnetons. (auth) (Canada)

3615 STUDY OF MEDIUM WEIGHT NUCLEI BY (γ,p) REACTION. Shoda, Katsufusa; Sugawara, Masumi; Saito, Teijiro; Miyase, Haruhisa; Suzuki, Atuto (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 3: No. 1, 34-47(Oct 1970). (In Japanese).

Study of E1 isobaric analog states of Sn nuclei was performed to investigate the N dependence of the states. Energy spectra of the emitted protons from the (e,e'p) reaction of Sn isotopes were observed. Excitation curves as the functions of electron energy were presented for the various Sn isotopes (^{117}Sn to ^{124}Sn). Sudden change was not seen in the neutron state to create the analog state. Gradual increase of the excitation energy was associated with the increase of neutron number. Mass-number dependence of the reduced transition probability to the analog states showed the same tendency as the Weisskopf unit, and it was confirmed that the effect of the change in the number of neutrons was negligible. Important relation between the analog states and giant resonance was suggested. Another study in relation to the analog states was carried out. The matrix elements of beta decay were estimated from the matrix elements of E1 transitions emittted from the analog states of daughter nuclei. Yield curves of (e,e'p) reaction for ^{139}La, ^{141}Pr, and ^{148}Sm were measured, and the radiative width obtained from the curves was used to estimate the beta decay matrix elements. The results were not in agreement with the theoretical values except in case of ^{141}Pr. The same kind of experiment was carried out for ^{207}Pb and ^{209}Bi. The beta decay matrix elements obtained from the experiment were in agreement with the calculated value based on the single-particle shell model in case of ^{207}Pb, but not in case of ^{209}Bi. (Japan)

3616 STUDY OF THE LANTHANIDE RECOIL PRODUCTS ARISING FROM THE INTERACTION OF HIGH-ENERGY PROTONS WITH TANTALUM NUCLEI. I. FORMATION CROSS SECTIONS OF THE LANTHANIDES FOR 580 MeV PROTONS. Neidhart, B.; Baechmann, K. (Technische Hochschule, Darmstadt, Ger.). J. Inorg. Nucl. Chem.; 33: No. 9, 2751-61(Sep 1971). (In German).

Tantalum was irradiated with 580 MeV protons and the rare earth elements were separated. The independent or cumulative cross sections for the formation of about 30 nuclides of the lanthanides are determined. The experimentally obtained σ-values are compared with theoretical σ-values which have been calculated using the Rudstam formulas. By variation of the different parameters the agreement is very satisfying. Thus it can be shown that the Rudstam formulas, which until now were tested only for nuclides with $Z \leq 47$, can be used for nuclides with high Z as well. A dependence on the Z of the target can be demonstrated for two parameters of the spallation formula. The agreement with the Rudstam formulas proves that the lanthanides at 580 MeV proton energy are formed by a single mechanism. These products are very likely formed by spallation. (auth) (UK)

3617 STRONGLY EXCITED 0^+ STATES OBSERVED IN (p,t) REACTIONS ON GADOLINIUM NUCLEI. Fleming, D. G. (Univ. of Copenhagen); Guenther, C.; Hagemann, G. B.; Herskind, B.; Tjoem, P. O. Phys. Rev. Lett.; 27: No. 18, 1235-8 (1 Nov 1971).

A single low-lying 0^+ state was observed with about 15% of the ground-state strength in the reactions ^{160,158,156}Gd(p,t)^{158,156,154}Gd at 18 MeV. The change in shape at N = 88 is observed in the reaction ^{154}Gd(p,t)^{152}Gd, with two excited 0^+ states being strongly populated. A similar change in the Sm nuclei has been observed earlier. An excited 0^+ state is observed in the reaction ^{152}Gd(p,t)-^{150}Gd with ~10% of the ground-state strengths. (auth)

3618 CALCULATION OF ^{238}Pu PRODUCTION DURING IRRADIATION OF ^{235}U AND ^{237}Np, TAKING ACCOUNT OF THE HARDNESS OF THE NEUTRON SPECTRUM. Galanin, A. D.;

Torlin, B. Z.; Trubenko, I. A. At. Energ. (USSR); 31: No. 3, 277-9(Sep 1971). (In Russian).

^{238}Pu and ^{238}Np production from the thermal-neutron irradiation of ^{235}U and ^{237}Np was measured at various neutron fluxes and at different hardness parameters of the spectrum. Resonance levels were considered weak (no blocking). Eight tables of calculated data are reproduced which cover neutron fluxes from 10^{13} to 10^{16} n/cm^2 · sec. (K.S.W.)

3619 MODES OF FORMATION OF TIN FISSION PRODUCTS. Erdal, B. R. (Washington Univ., St. Louis); Wahl, A. C.; Ferguson, R. L. J. Inorg. Nucl. Chem.; 33: No. 9, 2763-81(Sep 1971).

The modes of formation of ^{121}Sn, ^{123}Sn, ^{125}Sn, ^{127}Sn, and ^{128}Sn from thermal-neutron-induced fission of ^{235}U were investigated by separating indium and tin rapidly, in times as short as 4 sec after fission occurred, and measuring the amount of tin isotope formed by beta decay of indium precursors. It was also determined that 0.55 ± 0.15 of the short-lived (30-sec) ^{121}In is formed by beta decay of 13-sec ^{121}Cd. The sums of independent yields of the ^{123}Sn isomers and of the ^{125}Sn isomers are considerably greater than those estimated from extrapolated nuclear-charge distribution parameters. This apparent yield enhancement is attributed mainly to the closure of the 50-proton shell. (auth) (UK)

3620 NUCLEAR CHARGE DISTRIBUTION IN FISSION: FRACTIONAL CUMULATIVE YIELDS OF ^{131}Sb AND ^{131m}Te FROM THE SPONTANEOUS FISSION OF ^{252}Cf. Troutner, D. E. (Univ. of Missouri, Columbia. Oak Ridge National Lab., Tenn.); Runnalls, N. G. J. Inorg. Nucl. Chem.; 33: No. 8, 2271-9(Aug 1971).

The fractional cumulative yields of ^{131}Sb and ^{131m}Te from the spontaneous fission of ^{252}Cf were determined from a measurement of the radioactivity of ^{131}I found in samples of antimony and tellurium separated from other products of fission of ^{252}Cf. The yields are 0.65 ± 0.03 and 0.19 ± 0.01, respectively. A comparison of the fractional cumulative yield of ^{131}Sb to yields of ^{134}Te, ^{136}Xe, and ^{138}Xe for fission of ^{252}Cf and ^{235}U indicates that the effects of nuclear structure of the products on charge distribution are nearly the same for both fission processes. The results also indicate that, for this mass region, there may be less redistribution of charge during spontaneous fission of ^{252}Cf than during thermal-neutron-induced fission of ^{235}U. An approximate value, ~0.8, was measured for the ratio of the fractional independent yield of ^{131m}Te to that of ^{131g}Te. (auth)

3621 MASS DISTRIBUTION IN THE FISSION OF ^{238}U WITH ^{3}He IONS. Meyer, E. F. Jr.; Button, W. H.; Arnold, Kenneth (Lewis-St. Francis Coll. of Illinois, Lockport). J. Inorg. Nucl. Chem.; 33: No. 9, 2745-50(Sep 1971).

The cumulative yields of 13 fission fragments were measured by radiochemical methods in the fission of ^{238}U with ^{3}He ions of energies ranging from 14 to 30 MeV. By invoking Ford's procedure, the mass yield data were found to be consistent with the two-mode-of-fission hypothesis with a confidence level of 99%. (auth) (UK)

3622 NUCLEAR CHARGE DISTRIBUTION IN PHOTON-INDUCED FISSION OF ^{238}U. Umezawa, H. (Japan Atomic Energy Research Inst., Tokai). J. Inorg. Nucl. Chem.; 33: No. 9, 2731-43(Sep 1971).

Fractional chain yields of ^{86}Rb, ^{132}Te, ^{134}Cs, ^{136}Cs, ^{140}Ba, ^{148}Pm, and ^{160}Tb were determined radiochemically in the fission of ^{238}U induced with 13- to 55-MeV protons. From investigation of the excitation-energy dependence of these yield data, a common charge dispersion curve, $y = (2\pi\sigma^2)^{-\frac{1}{2}} \exp[-(Z - Z_p)^2/2\sigma^2]$, was found valid for all mass chains throughout this energy range. The resulting values of $2\sigma^2$ were found to be 0.97 ± 0.06. The pre-fission neutron emission is also discussed in connection with the fragment mass ratio. (auth) (UK)

3623 RELATIVE INTENSITIES OF PHOTONS FROM ^{133}Ba, ^{152g}Eu, ^{207}Bi, AND ^{241}Am IN THE ENERGY RANGE 30 TO 100 keV. Faermann, S.; Notea, A.; Segal, U. (Technion-Israel Inst. of Tech., Haifa, Israel). Trans. Amer. Nucl. Soc.; 14: No. 2, 500-1 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3624 MULTILEVEL ANALYSIS OF ^{235}U SCATTERING CROSS-SECTION DATA. Adler, D. B.; Adler, F. T. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc.; 14: No. 2, 804-5 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3625 STRENGTH FUNCTION AND RADIATION WIDTHS OF ^{232}Th. Rahn, F. J.; Camarda, H.; Hacken, G.; (and others) (Columbia Univ., New York). Trans. Amer. Nucl. Soc.; 14: No. 2, 805-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3626 MEASUREMENT OF (γ,n) CROSS SECTIONS OF ^{232}Th, ^{233}U, AND ^{237}Np WITH ALUMINUM CAPTURE GAMMA RAYS. Ahlfeld, C. E.; Baumann, N. P. (E. I. duPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 807-8 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3627 AVERAGED ^{238}U CAPTURE CROSS SECTIONS BETWEEN 100 AND 1200 eV. Silver, E. G.; de Saussure, G.; Perez, R. B. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 808-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3628 TRITIUM AND HELIUM YIELDS IN FAST FISSIONS OF ^{235}U. Fluss, M. J.; Dudey, N. D. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 809(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3629 TESTING OF URANIUM SECONDARY GAMMA-RAY PRODUCTION DATA. Ford III, W. E.; Muckenthaler, F. J.; Gillen, J. S. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 900-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3630 MEASUREMENT OF ABSOLUTE PROMPT GAMMA-RAY INTENSITIES PRODUCED BY 2-keV NEUTRON CAPTURE IN TUNGSTEN. Greenwood, R. C.; Reich, C. W. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc.; 14: No. 2, 905-6 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Nuclear Theory

Refer also to abstracts 3101, 3211, 3277, 3281, 3361, and 3363.

3631 (AWRE-O-40/71) MULTIGROUP NEUTRON DIFFUSION THEORY PERTURBATION. Program JINX. West, P. H.; Hemment, P. C. E.; Wilson, W. H. G. (Atomic Weapons Research Establishment, Aldermaston (England)). Jul 1971. 16p. Dep. NTIS (U. S. Sales Only). UK 13p.

A description is given of the program JINX which calculates the sensitivity of reaction rate ratios at the center of a system, as calculated by multigroup diffusion theory, to changes in neutron group cross section data. JINX was originally written and tested on the IBM 7030 (STRETCH); it has now been converted to run on the IBM 360/75 and its operation on this machine is described. (auth)

3632 (BNL-tr-445) ANALYTIC METHOD OF DESCRIBING THE INELASTIC SCATTERING OF ELECTRONS BY NUCLEI WITH EXCITATION OF LOW-LYING LEVELS. Luk'yanov, V. K.; Pol, Yu. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report JINR-P3-4061. 22p. Dep. NTIS.

A convenient analytic method of calculating the inelastic scattering cross sections allowing the use of macroscopic and microscopic nuclear models is developed. This method is based on a high-energy approximation and on the pole method of calculating the inelastic scattering amplitude. The method is suitable for any form of the radial transition density of the nucleus, determined beforehand within the framework of some arbitrary model. (J.F.P.)

3633 (BNL-tr-454) STATISTICAL EXPRESSION FOR NUCLEAR ENERGY. Tyapin, A. S. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Yadern. Fiz.; 13: No. 2, 32-42(1971). 18p. Dep. NTIS.

Mass formulas for nuclei based on the liquid-drop model are improved using the statistical model and a previously described method. The nucleon distribution in nuclei and the nuclear energy are considered. (J.F.P.)

3634 (BNL-tr-456) METHODS OF STUDYING NUCLEAR STRUCTURE. Solov'ev, V. G. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from At. Energ. (USSR); 30: No. 3, 37-43(1971). 18p. Dep. NTIS.

A review is given of problems related to the study of nuclear structure. (J.F.P.)

3635 (BNWL–1607) DRAFT: A COMPUTER CODE FOR THE CALCULATION OF FISSION PRODUCT ACTIVITY RATIOS. Oden, D. R.; Seybold, G. D. (Battelle Pacific Northwest Labs., Richland, Wash.). Jun 1971. Contract AT(45-1)-1830. 29p. Dep. NTIS.

Program DRAFT calculates information concerning fission events such as fuel isotopic concentrations and fission product disintegration rates at selected times during and after irradiation. The code was developed to provide analytical data on fission products for use in the determination of absolute neutron flux and exposure via nondestructive gamma scanning techniques. Equations used in the code are described and detailed input instructions are provided. Use of the code is illustrated with a test case, and both printed and plotted (optional) output are described. (auth)

3636 (COO–427-135) INTERACTION OF PHOTONS AND PARTICLES WITH NUCLEI. Final Report, July 1, 1956–October 31, 1971. (Notre Dame Univ., Ind. Dept. of Physics). 26 Oct 1971. Contract AT(11-1)-427. 17p. Dep. NTIS.

Summaries of research on elementary particle theory and theory for photon and particle reactions with nuclei are presented. A list of publications is included. (J.F.P.)

3637 (FRNC-TH–65) SPHERICAL NUCLEI MONOPOLE VIBRATIONS. Giannoni, Marie-Joya (Paris Univ., Orsay (France). Faculte des Sciences). 1970. 29p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Monopole modes of nuclei are excitations which can be described by collective vibrations conserving ground state symmetry. Such modes are studied using a formalism recently developed by Brueckner et al. in which the ground state energy is expressed as a function of the mass density. The equations of motion are then established, the nucleus being considered as a compressible liquid drop. The equations are solved for a square density distribution and, using two supplementary hypotheses, the case of a nucleus with a diffuse surface is treated. Spontaneous monopole transitions arising in pair production, and excitation by electron scattering, were studied. The results obtained are compared with previous results. (France)

3638 (FRNC-TH–101) TOTAL SEMI-REALISTIC EFFECTIVE n–n INTERACTIONS AND HARTREE–FOCK CALCULATIONS IN SPHERICAL NUCLEI BETWEEN He AND THE SUPERHEAVY NUCLEI. Saunier, Gerard (Grenoble Univ. (France)). 1971. 204p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A search for an effective interaction related as closely as possible to the realistic interaction, and valid at the first order of the perturbation theory is presented. The following selective criteria were introduced. The effective interactions envisaged were assigned to have a realistic tail, to saturate the nuclear matter, ^{16}O and ^{40}Ca, and also to have a strong even positive tensor part. Two interactions were defined in that manner. They saturate properly the nuclear matter and enable convenient binding energies and charge radii to be calculated for ^{4}He, ^{16}O, ^{40}Ca, ^{48}Ca, ^{56}Ni, ^{90}Zr and ^{208}Pb. The energy splitting of doublets obtained for the nuclei with spin saturated shells (^{16}O, ^{40}Ca) is almost the same as the experimental data. Large energy gaps are derived between the last filled state and the first empty state in the nuclei. The level sequence and density obtained for the upper part of ^{208}Pb spectrum are convenient, which enable ^{208}Pb to be shown strongly magic in agreement with the experiment. (France)

3639 (INR–1313) THREE BODY PROBLEM IN NUCLEAR PHYSICS. Wrzecionko, Jerzy (Institute of Nuclear Research, Warsaw (Poland)). 1971. 42p. (In Polish). Dep. NTIS (U. S. Sales Only).

The method of Bateman is applied to find the two body t-matrix off the energy shell. This method allows one to find the solution of the Faddeev equations with the local two-body interactions. The binding energy of ^{3}H and ^{3}He, electric form factors of these nuclei, and the neutron-deuteron scattering lengths in doublet and quartet states were calculated for several local nucleon-nucleon potentials. The dependence of the calculated quantities on the types of the nucleon-nucleon potentials is discussed. The comparison with experiment is made. (auth)

3640 (JINR–E4-6030) NON-ROTATIONAL STATES OF ODD DEFORMED NUCLEI IN THE REGION $179 \leq A \leq 185$. Soloviev, V. G.; Fainer, U. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 19p. Dep. NTIS (U. S. Sales Only).

The energies and structure of the ground and excited states of odd-A nuclei in the region $179 \leq A \leq 185$ are calculated on the basis of the Saxon–Woods single-particle level and wave function schemes. The calculated reduced B(E2) s.p.u. probabilities from the ground states are given. It should be noted that the calculations for the nuclei considered are given for the first time. (auth)

3641 (NP–18940) ANALYSIS OF AN INTERMEDIATE STRUCTURAL MODEL IN NUCLEAR REACTIONS. Martinez, Juan Quintanilla (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1971. 191p. (In Spanish). Dep. NTIS (U. S. Sales Only).

Thesis.

The general expressions of a problem of two-channel nuclear reactions are established and developed. The interaction between the channels is specified. The quantities relevant to the elastic and reaction cross sections are calculated. The numerical results are given. The conditions under which the two-channel problem is equivalent to a one-channel problem are established. (tr-auth)

3642 (NYO–4032-65) FOLDED DIAGRAMS. Kuo, T. T. S. (State Univ. of New York, Stony Brook. Dept. of Physics). 1971. 32p. Dep. NTIS.

A review of folded diagrams and their connection with the model-space eigenvalue problem for nuclear structure theory is given. (J.F.P.)

3643 (ORO–3765-38) THEORETICAL STUDIES IN THE THREE-NUCLEON SYSTEM. Technical Report No. 72-028. Lavine, James P. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Aug 1971. Contract AT(40-1)-3765. 145p. Dep. NTIS.

Thesis.

An angular momentum decomposition is presented for the Faddeev–Lovelace formulation of the three-body problem. The result is a coupled system of integral equations with two continuous variables. The limits of integration in the integral term are independent of the integration variables. Several aspects of the three-nucleon problem are investigated with this formalism. The first concern is with theoretical approaches to neutron-deuteron break-up calculations with local potentials. The methods that are used with separable potentials are reviewed and the reasons why they are inappropriate for local potentials are indicated. Several local potential techniques have been proposed and these are discussed. Two new approaches to break-up calculations are presented. One involves complex momenta and contour distortions to avoid the singularities due to the bound-state poles of the two-body scattering amplitudes and to the poles of the free three-particle Green's function. A determination is made of the extent to which the contours can be distorted before other singularities of the two-body scattering amplitudes are crossed. The second approach uses only real momenta and takes advantage of the independence of the integration limits from the variables of integration in the version of the Faddeev-Lovelace equations used here. Integral equations are added together until both integration variables go from zero to infinity and then the singularities are removed by subtraction. The final result is a system of equations which are suitable for replacement by a set of linear equations. Both of these approaches to break-up require large-scale numerical calculations and before they are undertaken, much numerical experience is needed with simpler three-nucleon problems. Results are presented for two investigations that are motivated by this need to understand the details of the three-nucleon problem. The first investigation is a study of three-nucleon properties with separable potentials to determine the critical regions of momentum space. The two-body scattering amplitudes are multiplied by functions of momentum that either suppress or enhance their contribution whenever a momentum argument exceeds a cutoff value. Binding energies and particle-bound-pair elastic scattering phase-shifts below the break-up threshold are shown as functions of the cutoff values. The most critical region is for both momentum variables between 0 and about 2 inverse fermis. There is no discernible contribution from two-body scattering amplitudes with a momentum variable greater than 5 inverse fermis. Several separable potentials, including some with repulsion, are used in establishing this result, which is contrary to expectations from nuclear matter calculations. Possible reasons for this discrepancy are discussed. Local potentials are used in an investigation of three-nucleon binding energies for phase-shift equivalent potentials. These are generated through radial distortion unitary transformations on a sum of two Yukawa potentials. The transformed and the untransformed potentials all lead to approximately the same ground-state energies, which is surprising in the light of prior nuclear matter calculations. The ratio method of Malfliet and Tjon is discussed in detail and is used to obtain some of the binding energies. This

method breaks down for several of the transformed potentials, so Padé approximants are used to find their ground states. The numerical difficulties that are encountered indicate that it is probable that scattering calculations with local potentials will have similar problems. Thus, extensive preliminary investigations of any proposed method are needed. (auth)

3644 (UCRL-73368) NEUTRON-PROTON BREMSSTRAHLUNG INCLUDING GAUGE-INVARIANT TERMS ARISING FROM THE NUCLEAR POTENTIAL. Brown, V. R. (California Univ., Livermore. Lawrence Radiation Lab.). 11 Aug 1971. 7p. (CONF-710915-1). Dep. NTIS.

From Symposium on the two-body force in nuclei; Ann Arbor, Mich. (7 Sep 1971).

The minimal-gauge-invariant interactions are introduced in momentum space in the nonlocal framework. The discussion is limited to the long-wavelength dipole approximation. (J.F.P.)

3645 (UCRL-Trans-10552) SINGLE-PARTICLE ENERGIES, SAXON-WOODS WAVE FUNCTIONS, AND ENERGY LEVELS OF ODD NUCLEI IN THE REGION OF THE ACTINIDES. Gareev, F. A.; Ivanova, S. P.; Malov, L. A.; Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Translated for Univ. of California, Lawrence Livermore Lab., from report JINR-P4-5470. 37p. Dep. NTIS.

Single-particle states deduced from the Saxon-Woods potential for nuclei in the region $234 < A < 250$ are described. The energies and wave functions are calculated for odd nuclei, taking into account superconducting pairing correlations and interactions between quasiparticles and phonons. (J.F.P.)

3646 HINDRANCE PHENOMENA IN UNIQUE FIRST- AND THIRD-FORBIDDEN β-DECAY. Towner, I. S. (Nuclear Physics Lab., Oxford); Warburton, E. K.; Garvey, G. T. Ann. Phys. (N.Y.); 66: No. 2, 674-96(Aug 1971).

The characteristic hindrance of all unique n-forbidden beta decays (with n odd) among light nuclei ($A \leq 50$) can be traced to correlations introduced by the repulsive $T = 1$ particle-hole force. These correlations are examined in perturbation theory. The results explain the experimentally observed hindrance, and, in a large proportion of the cases, good numerical agreement is also obtained (auth)

3647 DIFFRACTION MODEL OF TRANSFER REACTIONS. Alder, K.; Trautmann, D. (Univ., Basel). Ann. Phys. (N. Y.); 66: No. 2, 884-904(Aug 1971).

The diffraction model of transfer reactions is studied. The accuracy of the different suggested approximations for the radial integrals or for the reaction amplitude is investigated. Some selected examples illustrate these approximations. (auth)

3648 VALIDITY OF THE SOPKOVICH APPROXIMATION. Blair, J. S. (Univ. of Washington, Seattle). Ann. Phys. (N. Y.); 66: No. 2, 721-37(Aug 1971).

Distorted-wave Born-approximation calculations for high-energy peripheral collisions are frequently circumvented by a simple prescription, emerging from the high-energy WKB approximation, in which the plane-wave Born-approximation amplitudes are multiplied by the factor $\exp(i[\delta_l + \delta_{l'}])$, where δ_l and $\delta_{l'}$ are phase shifts characteristic of elastic scattering in the incident and final channels, respectively. The validity of this recipe for medium-energy nuclear reactions is tested through numerical calculations with a simple nonrelativistic potential model. For sufficiently weak potentials, the recipe appears quantitatively reliable, but, in realistic situations of moderate or strong absorption, although it frequently approximates the exact angular distribution well, this prescription can give quantitatively unreliable values for the important partial-wave amplitudes as well as miss important features of the cross section. The implications of the numerical results for several related approximations are also discussed. (auth)

3649 SPECTRA OF NEAR-MAGIC ODD-ODD NUCLEI AND THE EFFECTIVE INTERACTION. Schiffer, J. P. (Argonne National Lab., Ill. Univ. of Chicago). Ann. Phys. (N. Y.); 66: No. 2, 798-809(Aug 1971).

The body of experimental data on the spectra of near-magic odd-odd nuclei is reviewed, and two-body matrix elements are extracted wherever possible. The data show simple systematics, which are consistent with a delta-function force for spectra arising from the coupling of nonidentical orbits and are somewhat different for identical orbits. The multipole coefficients of the apparent two-body interaction are also presented. (auth)

3650 SEMICLASSICAL THEORY OF A NUCLEAR JOSEPHSON EFFECT IN REACTIONS BETWEEN HEAVY IONS. Dietrich, Klaus (Univ. of Stony Brook, Long Island, N. Y.). Contract AT(30-1) 4032. Ann. Phys. (N. Y.); 66: No. 2, 480-508 (Aug 1971).

A semiclassical treatment of heavy-ion reactions below the Coulomb barrier is given with special emphasis on a pair transfer between superconducting nuclei. The cross section is explicitly given with a schematic model. An enhancement of the pair transfer due to superconductivity is found that, in favorable cases, may amount to a factor of 100 to 900 in the cross section. (auth)

3651 ANALYSIS OF SEPARATION ENERGIES. Bassichis, W. H.; Strayer, M. R. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1) 2098. Ann. Phys. (N. Y.); 66: No. 2, 457-79 (Aug 1971).

The various quantities, calculated with microscopic models, that have been called separation energies are discussed and related. The relationship of these quantities to experimentally observed quantities is also discussed. The Hartree-Fock method provides the framework for all discussions, and is used to carry out calculations of the various quantities, which are then compared to the results of experiments on ^{16}O. (auth)

3652 CORE POLARIZATION AND THE EFFECTIVE INTERACTION BETWEEN NUCLEONS IN A NUCLEUS. Kirson, Michael W. (Weizmann Inst. of Science, Rehovot, Israel). Ann. Phys. (N. Y.); 66: No. 2, 624-50(Aug 1971).

Core polarization is taken into account to all orders by systematic inclusion of particle-hole scattering, self-screening of phonons, and modification of the vertices connecting single-particle to two-particle-one-hole states and single-hole to two-hole-one-particle states. Problems of convergence are overcome by converting the sum of perturbation theory diagrams into closed equations. A set of coupled nonlinear equations for the particle-hole interaction is derived and solved, and the solution is used to compute the effect of core polarization to all orders. The self-screening strongly suppresses the RPA enhancement of the core phonons, the net effect being close to TDA phonons, while the vertex modification drastically changes the contributions of the various phonons. The final result for the core polarization is very different from the lowest-order effect for low-lying energy levels, as it is generally quite small. (auth)

3653 DEFORMATION PRODUCING TENDENCY OF THE $T = 1$ INTERACTION. Sharma, S. K.; Bhatt, K. H. (Physical Research Lab., Ahmedabad, India). Phys. Lett.; 36B: No. 6, 550-2(18 Oct 1971).

Deformed Hartree-Fock calculations in the 1f-2p shell show that the $T = 1$ component of the effective interaction has almost the same deformation-producing tendency as the $T = 0$ component. (auth)

3654 EXPERIMENTAL OBSERVATIONS OF PARITY NONCONSERVATION IN NUCLEAR FORCES. Lobashov, V. M. Vestn. Akad. Nauk SSSR; No. 2, 58-64(Feb 1969). (In Russian).

Among the four known fundamental interactions of elementary particles: strong, electromagnetic, weak, and gravitational, the weak type does not conserve parity. Experimental indications of nonconservation of parity in electromagnetic decay of nuclei are discussed. Weak interactions between various particles, e.g., between neutrino and μ meson, or neutron and proton, are considered. A special apparatus for measuring small circular polarization of γ-quanta is diagrammed and its calibration and use are described. (K.S.W.)

3655 FISSION OF HEAVY EVEN-N NUCLEI BY s- AND p-NEUTRONS. Vorotnikov, P. E. At. Energ. (USSR); 31: No. 1, 18-22(Jul 1971). (In Russian).

A direct comparison of average fission widths $\overline{\Gamma}_f$ obtained in the experiments on heavy nuclei fission by s- and p-neutrons is given. $\overline{\Gamma}_f^p$ are shown to be considerably greater than $\overline{\Gamma}_f^s$ for the nuclei having $Z^2/A < 37$ at the same excitation energy taking into consideration the contribution by s-resonances with abnormally large values of Γ_f^s. (auth)

3656 DOORWAY STATES AND PRIMARY NEUTRON CAPTURE GAMMA-RAYS. Beer, M. (Brookhaven National Lab., Upton, N. Y.). Ann. Phys. (N. Y.); 65: No. 1-2, 181-211(15 Jun 1971).

The projection operator formalism of nuclear reactions utilizing the doorway-state assumption is applied to neutron-capture reactions in the one-photon approximation. The transition matrix divides into three parts, a direct-capture term, a semidirect term proceeding through doorway states, and a compound-nucleus part. The same doorway states contributing to semidirect capture are involved in the resonance term. The giant dipole resonance is included in the theory. Expressions for the correlation coefficients

are given. An isolated doorway responsible for radiation to several final states and also connecting entrance channel and compound nucleus results in the first two coefficients being unity. The theory is extended to include the two-group model of the compound nucleus. Application of the theory is made specifically to neutron-capture experiments in ^{93}Nb, ^{165}Ho, ^{166}Er, ^{169}Tm, and ^{183}W. Capture γ-ray results to date can be understood in terms of the theory. (auth)

3657 ANALYTICAL MODEL OF THE EFFECTIVE CROSS SECTION FOR NUCLEAR REACTIONS USING THERMAL NEUTRONS. Naumov, V. A.; Semashko, A. P. pp 181-8 of Byulleten' Informatsionnogo Tsentra po Yadernym Dannym. /Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). (In Russian).

An equation is given which describes the effective cross section of thermal-neutron-induced nuclear reactions of nuclei of given isotopic composition, and with a given asymptotic moderating capacity of the reactor environment. This analytical model was used with a computer to make a comparison of thermal-neutron absorption cross sections at 300, 600, 900, and 1,2000°K in water, zirconium hydride, and the isotopes ^{239}Pu and ^{238}U. (K.S.W.)

3658 ISOSPIN SPLITTING OF THE GIANT DIPOLE RESONANCE, AND MUON CAPTURE. Goulard, B.; Joseph, J.; Ledoyen, F. (Laval Univ., Quebec). Phys. Rev. Lett.; 27: No. 18, 1238-41(1 Nov 1971).

The correspondence between the upper fragment of the split electromagnetic giant dipole resonance and the parent dipole mode excited by muon capture is investigated for nuclei with a neutron excess. Results already found for light (N = Z) nuclei are extended to heavier (N > Z) nuclei, and new types of experiments to demonstrate the isospin origin of this splitting are suggested as a result. (auth)

3659 MANY-PARTICLE SYSTEMS. VII. ANGULAR MOMENTA AND AN IMPROVED LOWER BOUND: AN APPROACH TOWARDS SHELL THEORY. Carr, R. J. M. (London Univ.); Post, H. R. J. Phys., A (London); 4: No. 5, 665-78(Sep 1971).

The shell model previously developed by Carr and Post (1968), consisting of strictly independent particles, is shown to provide lower bounds to the energies of any N-fermion system for states of each angular momentum separately. An improved lower-bound shell model retaining antisymmetry in all N particles is derived, and applied to Hooke's law, inverse square, rectangular well, and exponential interactions. Upper bounds to the deviations of our model energy values from the exact values are given. An approach to shell theory is sketched. (auth) (UK)

3660 NEUTRON STRENGTH FUNCTIONS. Zaretskii, D. F.; Urin, M. G. (Moscow Engineering Physics Inst.). JETP Lett. (USSR) (Engl. Transl.); 13: No. 11, 460-2(5 Jun 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 11, 646-50(5 Jun 1971).

Nonoverlapping compound-nucleus resonances in the cross section for elastic scattering of slow neutrons are described by a strength function, which, as a function of A, exhibits resonant forms connected with the existence of single-particle levels in the optical potential. The optical model with complex potential describes qualitatively the position and width of the form resonances; however, the experimental values are markedly lower than those obtained by using the optical model in the region of the minimum of the strength function (A ~ 120 for s-wave neutrons). A possible explanation for this discrepancy is given. (R.W.R.)

3661 IMPROVED DECAY-HEAT CALCULATION FOR ^{239}Pu AND ^{238}U FISSION PRODUCTS. Marr, D. R.; Bunch, W. L. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 548-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3662 AMBIGUITIES IN R-MATRIX PARAMETERS FOR INTERFERING RESONANCES WITH TWO FISSION CHANNELS. Adler, D. B.; Adler, F. T. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc.; 14: No. 2, 803-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3663 REDUCTION OF GAMMA SELF-SHIELDING USING THE FISSION MULTIPLICITY DETECTOR. Gozani, T. (Univ. of Tel-Aviv, Israel); Costello, D. G. Trans. Amer. Nucl. Soc.; 14: No. 2, 809-10(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3664 TREATMENT OF WIDE-SCATTERING RESONANCES IN DEFINING ELASTIC REMOVAL CROSS SECTIONS IN THE BONDARENKO SCHEME. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 838-9 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3665 NUCLEON PRODUCTION CROSS SECTIONS FOR HIGH-ENERGY TRANSPORT CALCULATIONS. O'Brien, Keran (Atomic Energy Commission, New York). Trans. Amer. Nucl. Soc.; 14: No. 2, 903-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 2454, 2550, and 3096.

3666 (70-CNA-632) REALISTIC COMPARISON OF ELECTRICAL GENERATION SYSTEMS: SUMMATION. Warnock, Gavin J.; Long, Bryan G. (Acres (H. G.) Ltd., Toronto (Ontario)). [nd]. 5p. (CONF-700564-21). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association; Toronto, Canada (24 May 1970).

The various technical, economic, and political factors that influence a country's utilities in selecting a power reactor type are examined. (H.D.R.)

3667 (CNEA-298) FOREIGN POLICIES ON NUCLEAR POWER PLANTS. Quihillalt, Oscar A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1971. 30p. (In Spanish). Dep. NTIS (U. S. Sales Only).

The evolution of power reactors and the number of reactors expected to be operating during the period 1970 to 1980 are discussed. Factors that influence the selection of power reactors are described. The power reactor development policies of various countries are briefly reviewed. (H.D.R.)

3668 (FIND-50280(11-71)) FIND: SURRY POWER STATION, UNITS 1 AND 2. Smith, James G. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 29 Oct 1971. 20p. (FIND-50281(11-71)). Dep. NTIS.

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames on the microfiche. (J.M.J.)

3669 (GULF-GA-A-10809) CHEMICAL IMPURITIES IN THE HELIUM COOLANT AT THE PEACH BOTTOM HTGR. Burnette, R. D.; Bell, W. E.; Turner, R. F.; Knapp, W. J. (Gulf General Atomic Co., San Diego, Calif.). 23 Aug 1971. Contract AT(04-3)-214. 49p. (CONF-710923-1). Dep. NTIS.

From Symposium on coolant chemistry and carbon transport; Brussels, Belgium (29 Sep 1971).

During the operation of Core 1 and part of Core 2 in the Peach Bottom (HTGR) atomic power station, tests were performed to (1) measure the concentration of chemical impurities in the helium coolant and (2) ascertain the sources of the impurities. The results of these tests are presented. (auth)

3670 (SRARI-P-66) INVESTIGATION OF PLUTONIUM ISOTOPE BUILDUP IN WWPR-1 REACTOR FUEL OF NOVO-VORONEZH APS. Gabeskiriya, V. Ya.; Belokopytov, V. S.; Miller, O. A.; Simakin, G. A.; Burnyakov, L. I.; Pakhomov, Z. I.; Vladimirova, N. A.; Matyashchuk, I. V. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1970. 16p. (In Russian). INIS.

The ^{235}U decrease and the Pu buildup in the fuel of the Novo-Voronezh atomic electric power plant was measured as a function of the fraction of burnup. For a burnup of 23 kg/ton of U, the portion of Pu fission reaches 50%. The heavy isotope content (^{240}Pu, ^{241}Pu, ^{242}Pu) in the accumulated Pu amounts to 40%. Measured results satisfactorily agree with the experimental. (tr-auth) (INIS)

3671 (WCAP-7756) POWER DISTRIBUTION MONITORING IN THE R. E. GINNA PWR. Barry, R. F.; Brandon, R. W.; Kutz, J. P.; Nath, R. J. (Westinghouse Nuclear Energy Systems, Pittsburgh, Pa.). Sep 1971. 97p.

Power distribution measurements for the Robert E. Ginna Power Reactor Unit 1 are presented. The three core monitoring systems used are described. The monitoring systems include: the excore nuclear detector system; the core exit thermocouple system; and the movable incore detector system. (D.C.C.)

3672 VANDELLOS NUCLEAR POWER PLANT. Marti, M. S. (Hidroelectric de Cataluna, Barcelona). J. Inst. Nucl. Eng.; 12: No. 5, 127-8(Sep-Oct 1971).

A description is given of the first nuclear power plant to be built in Catalonia, expected to be in operation early in 1972. The reactor is CO_2-cooled and graphite-moderated, and uses natural U fuel; its capacity will be 500 MW(e). A prestressed concrete pressure vessel, lined with a steel membrane, is employed, having about 200 penetrations. Refuelling will be carried out on-load. An auxiliary steam raising plant is provided, using gas-oil as fuel, to provide an additional source of steam for the turbo-blowers, so that residual heat can be removed from the core should this be necessary after shut-down. The plant is automatically controlled by two parallel-connected computers, either of which can be operated independently in the event of a fault in the other. The total estimated cost of the project is 11,000 million pesetas. The future nuclear power plant program in Spain is also outlined. (UK)

3673 SEQUOYAH NUCLEAR STEAM SUPPLY SYSTEM. Eicheldinger, C. (Westinghouse Electric Corp., Pittsburgh). Nucl. Eng. Int.; 16: No. 185, 850-6(Oct 1971).

The nuclear steam supply system for the Sequoyah plant, rated at 3423 MW(t), consists of the reactor vessel, four coolant loops each including a pump and steam generator, and one pressurizer. Details of these are presented and principal data are tabulated. There are descriptions of various supporting systems including those for chemical and volume control, residual heat removal, safety injection, and radioactive waste disposal. Fuel handling facilities are also described. (UK)

3674 SEQUOYAH REACTORS: FUEL AND FUEL COMPONENTS. Heil, August L. (Westinghouse Electric Corp., Pittsburgh). Nucl. Eng. Int.; 16: No. 185, 857-9(Oct 1971).

Details are presented of the fuel assemblies and the fuel rods, which consist of UO_2 in Zircaloy-4. Fuel assembly fabrication is outlined. Features adopted to increase reliability and minimize fuel cycle costs are described. They include the use of chemical shim control, rod cluster control, burnable poison in the initial core cycle, and prepressurized fuel rods. Non-uniform loading of fuel is maintained by a cycled core-management technique. (UK)

3675 IN-PILE PERFORMANCE OF NUMEC FUEL IN THE CONNECTICUT-YANKEE ATOMIC POWER STATION. Bleiberg, M. L. (NUMEC, Pittsburgh); Meieran, H. B.; Newman, J. B.; (and others). Trans. Amer. Nucl. Soc.; 14: No. 2, 562-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3676 APPROXIMATION OF NUCLEAR FLUX DISTRIBUTIONS IN OPERATING POWER REACTORS. Ryals, H. W. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 750-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3677 INDUSTRIAL PREFERENCES FOR NUCLEAR ENGINEERING MANPOWER. Harrison, W. C. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Harms, A. A. Trans. Amer. Nucl. Soc.; 14: No. 2, 759-60(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3678 ANALYTICAL STUDIES OF IODINE REMOVAL BY SPRAYS IN THE DONALD C. COOK NUCLEAR PLANT. Milioti, S. J. (American Electric Power Services, New York); Sherman, A.; Ritzman, R. L.; Gieseke, J. A. Trans. Amer. Nucl. Soc.; 14: No. 2, 772(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3679 FAST REACTOR POWER. Boltz, G. L. Phys. Bull (London); 22: 598(Oct 1971).

Since the power station customers and the construction consortia have been involved in all stages of planning of the UKAEA's prototype fast reactor (PFR), no time delay should occur between proving of the first fuel charge and a decision about the first 1300 MW commercial station (CFR). The capital cost of the CFR will be about the same as that of the latest thermal (or slow) reactor stations, about £100/kW installed, while the running costs will be lower, so that the cost of electricity sent out may well be a half of that from any other nuclear power station. Moreover the breeding of new nuclear fuel will lead to great economy in uranium and when the correct balance between slow and fast reactors is eventually reached there will be a nearly self-sustaining system and the price of uranium will hardly affect the economics. The phenomena of breeding is examined and the progress in the design of the fuel and the choice of coolant are considered. The novel acoustic diagnostic monitoring used in the PFR is explained. (UK)

3680 NUCLEAR POWER FOR ELECTRICITY GENERATION. Bainbridge, G. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). Chartered Mech. Eng.; 18: No. 8, 292-303(Sep 1971).

Estimated world generating capacity and fuel requirements, to-

gether with forecasts of electricity demands and supply in the U.K., to the year 2000, are summarized. A brief review of the chief characteristics of existing and proposed types of nuclear stations is presented. It is concluded that at the end of the century nuclear stations will be operating on a substantial scale and will include gas-cooled reactors, water reactors and fast breeders. (UK)

3681 NUCLEAR POWER IN THE HELSINKI CITY ENERGY SUPPLY. Mikola, J. (Helsinki Electricity Works). Sahko; 44: No. 7-8, 167-70(Jul-Aug 1971). (In Finnish).

Long-range electricity and district heating plans for the Helsinki urban area are described. According to the plans, two nuclear heating plants will, for instance, be built in the Helsinki urban area. The Vuosaari plant is scheduled for operation at the start of the 1980's, with an electric power of 600 MW and district heating power of 1300 MW. The Miessaari plant is scheduled for building at the start of the 1990's, with an electric power of 720 MW and district heating power of 1000 MW. (auth) (FINLAND)

3682 NUCLEAR POWER PLANTS CONNECTED WITH PUMPED STORAGE PLANTS BY THE INLAND LAKES. Kilpelaeinen, J. E. (Imatran Voima Osakeyhtioe, Helsinki). Sahko; 44: No. 5-6, 143-8(May-Jun 1971). (In Finnish).

Four alternatives are described in which the use of either underground pumped storage plant or conventional plant is suggested in order to mix and divert the cooling waters. Some of the alternatives require that the nuclear power plant be sited in a cave. (auth) (FINLAND)

Operation and Economics

3683 (DOCKET-50016-131) ENRICO FERMI ATOMIC POWER PLANT. Report for April 1971. (Power Reactor Development Co., Detroit, Mich.). 7 Sep 1971. 11p. (PRDC-EF-92; EF-92). Dep. NTIS.

3684 (DOCKET-50016-133) ENRICO FERMI ATOMIC POWER PLANT. Report for June 1971. (Power Reactor Development Co., Detroit, Mich.). 15 Nov 1971. 15p. (PRDC-EF-94). Dep. NTIS.

3685 (DOCKET-50245-101) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Additional Information Concerning Cause and Effect of Transient on October 10, 1971. (Millstone Point Co., Hartford, Conn.). 16 Nov 1971. 5p. Dep. NTIS.

Additional information concerning a turbine control system instability of October 10, 1971 is presented. (D.C.C.)

3686 (DOCKET-50255-56) PALISADES PLANT. Difficulty with Control Rod Mechanisms. (Consumers Power Co., Jackson, Mich.). 19 Nov 1971. 10p. Dep. NTIS.

3687 (DOCKET-50263-90) MONTICELLO NUCLEAR GENERATING PLANT. Report of Occurrence, Valve Closures. (Northern States Power Co., Minneapolis, Minn.). 9 Sep 1971. 2p. Dep. NTIS.

On August 9, 1971, a reactor water cleanup demineralizes outboard isolation valve failed to close when a reactor low water level signal existed. The problem was caused by an improperly secured wire in the control circuit for the valve motor. On August 26, 1971, a main steam isolation valve had a closure time of 2.0 seconds during a routine surveillance test. The valve closing time was adjusted to meet specifications of greater or equal to 3 seconds and less than or equal to 5 seconds. (D.C.C.)

3688 (DOCKET-50336-26) MILLSTONE NUCLEAR POWER STATION, UNIT 2. Appendix D. Approvals and Permits. (Millstone Point Co., Hartford, Conn.). 29 Nov 1971. 18p. Dep. NTIS.

3689 (JUL-778-RG) NUCLEAR REACTORS AS A CONTRIBUTION TO ENVIRONMENTAL PROTECTION. Bonnenberg, Heiner; Meinecke, Juergen (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung. Technische Hochschule, Aachen (West Germany)). Jun 1971. 76p. (In German). Dep. NTIS (U. S. Sales Only).

The introduction of nuclear energy within the Federal Republic of Germany is studied. Air pollution problems with power plants are described. A study for the year 2000 shows that the content of SO_2 in the air could be reduced by a factor ≈4, the content of lead by a factor ≈2, the content of C_hH_m by a factor ≈2, the content of dust by a factor ≈2, and the content of NO_x by a factor ≈2.5. (26 references) (auth)

3690 BWR STARTUP EXPERIENCE IN 1971. Burdsale, G. D. (General Electric Co., San Jose, Calif.); Poepplemeir, V.; Smith, R. L.; (and others). Trans. Amer. Nucl. Soc.; 14: No. 2, 708(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3691 STARTUP OF POINT BEACH NO. 1. Reed, G. A. (Wisconsin Michigan Power Co., Two Rivers, Wis.); Cameron, P. M. Trans. Amer. Nucl. Soc.; 14: No. 2, 708-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3692 STARTUP EXPERIENCES: MIHAMA UNIT NO. 1. Mitlo, T. J. (Westinghouse Electric Co., Pittsburgh); Fujii, T. Trans. Amer. Nucl. Soc.; 14: No. 2, 709(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3693 STARTUP EXPERIENCES: H. B. ROBINSON UNIT NO. 2. Leblang, Joseph J. (Westinghouse Electric Corp., Pittsburgh); Thompson, Floyd L.; Beatty, Guy T. Jr. Trans. Amer. Nucl. Soc.; 14: No. 2, 709-10(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3694 MINIMUM TRANSMISSION COSTS FOR IDEALIZED NUCLEAR PLANT CLUSTERS. Omberg, Ronald P. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 711(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3695 ESTIMATED FUTURE CAPITAL COSTS OF CENTRAL STATION STEAM-ELECTRIC POWER PLANTS. Bennett, L. L.; Bowers, H. I.; Myers, M. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 758-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Safety and Siting

3696 (DOCKET-50010-97) DRESDEN NUCLEAR POWER STATION, UNIT 1. Augmented In-Service Inspection to Meet Interim Core Cooling Acceptance Criteria. (Commonwealth Edison Co., Chicago, Ill.). 11 Nov 1971. 10p. Dep. NTIS.

3697 (DOCKET-50146-97) SAXTON REACTOR. Change Report No. 25, Amendment No. 1. (Saxton Nuclear Experimental Corp., Pa.). 10 Nov 1971. 4p. Dep. NTIS.

Revised information is presented concerning a vent line installed from the pressurizer to the purification surge tank. Operating limits for the pressurizer are described. (D.C.C.)

3698 (DOCKET-50206-128) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Technical Specifications, Change No. 3. (Division of Reactor Licensing (AEC), Washington, D. C.). 16 Nov 1971. 3p. Dep. NTIS.

A revised technical specification is presented concerning an increase in the Core 2 burnup from 17000 MWD/MTM to 18000 MWD/MTM. (D.C.C.)

3699 (DOCKET-50219-151) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Temporary Technical Specifications Change. (Jersey Central Power and Light Co., Morristown, N. J.). 22 Nov 1971. 2p. Dep. NTIS.

Revised technical specifications are presented concerning the atmosphere composition levels for the primary containment system. (D.C.C.)

3700 (DOCKET-50245-102) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Environmental Report, Operating License Stage. (Millstone Point Co., Hartford, Conn.). 29 Nov 1971. 391p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Geological, hydrological, and meteorological data for the reactor site are included. (D.C.C.)

3701 (DOCKET-50245-103) MILLSTONE NUCLEAR POWER STATION, UNITS 1 AND 2. Appendix A. Report to the New England Planning Committee on the New England Regional Power Supply as It Would be Affected by a Delay and Shutdown of Nuclear Capacity. (Millstone Point Co., Hartford, Conn.). 29 Nov 1971. 39p. (DOCKET-50336-27). Dep. NTIS.

The effects on the New England bulk power system of a long-period shutdown of the Millstone Point Power Reactor Unit 1 and a long-period delay in the installation of the Millstone Point Power Reactor Unit 2 are described. (D.C.C.)

3702 (DOCKET-50245-104) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Appendix C. Approvals and Permits. (Millstone Point Co., Hartford, Conn.). 29 Nov 1971. 26p. Dep. NTIS.

3703 (DOCKET-50245-105) MILLSTONE NUCLEAR POWER STATION, UNITS 1 AND 2. Appendix B, Volume 1. Millstone Point Environmental Studies. (Millstone Point Co., Hartford, Conn.). 29 Nov 1971. 541p. (DOCKET-50336-28). Dep. NTIS.

Limnological data for the reactor site are presented. (D.C.C.)

3704 (DOCKET-50245-106) MILLSTONE NUCLEAR POWER STATION, UNITS 1 AND 2. Appendix B, Volume 2. Preoperational Environmental Radiation Survey Program. Summary Program, April 1967-June 30, 1970. (Millstone Point Co., Hartford, Conn.). 29 Nov 1971. 610p. (DOCKET-50336-29). Dep. NTIS.

3705 (DOCKET-50245-107) MILLSTONE NUCLEAR POWER STATION, UNITS 1 AND 2. Appendix B, Volume 3. Preliminary Site Evaluation Dated May 14, 1965. (Millstone Point Co., Hartford, Conn.). 29 Nov 1971. 360p. (DOCKET-50336-30). Dep. NTIS.

Geological, hydrological, and meteorological data for the reactor site are presented. (D.C.C.)

3706 (DOCKET-50250-55) TURKEY POINT PLANT, UNITS NO. 3 AND NO. 4. Final Safety Analysis Report, Supplement No. 40. (Florida Power and Light Co.). 15 Nov 1971. 189p. (DOCKET-50251-50). Dep. NTIS.

Revised and additional information is presented concerning design parameters and operations aspects of the reactors. (D.C.C.)

3707 (DOCKET-50254-58) QUAD-CITIES STATION, UNITS 1 AND 2. Additional Information Concerning Fuel Loading at Unit 2, and Start-Up Testing at Units 1 and 2. (Commonwealth Edison Co., Chicago, Ill.). 10 Nov 1971. 7p. (DOCKET-50265-50). Dep. NTIS.

3708 (DOCKET-50254-59) QUAD-CITIES STATION, UNITS 1 AND 2. Additional Information Concerning Fuel Loading at Unit 2, and Start-Up Testing at Units 1 and 2. (Commonwealth Edison Co., Chicago, Ill.). 18 Nov 1971. 3p. (DOCKET-50265-51). Dep. NTIS.

3709 (DOCKET-50254-60) QUAD-CITIES STATION, UNITS 1 AND 2. Environmental Impact Report: Supplementary Information to the Environmental Report, Errata Sheets. (Commonwealth Edison Co., Chicago, Ill.). 16 Nov 1971. 47p. (DOCKET-50265-52). Dep. NTIS.

Corrected data concerning radioactive and thermal discharge from the reactors are presented. (D.C.C.)

3710 (DOCKET-50255-55) PALISADES PLANT. Environmental Report, Additional Information Regarding Discharges. (Consumers Power Co., Jackson, Mich.). 11 Nov 1971. 24p. Dep. NTIS.

3711 (DOCKET-50259-29) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. Draft Environmental Statement, Supplements and Additions. (Tennessee Valley Authority, Chattanooga). 5 Nov 1971. 233p. (DOCKET-50260-28; DOCKET-50296-27). Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

3712 (DOCKET-50259-30) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 15. (Tennessee Valley Authority, Chattanooga). 5 Nov 1971. 235p. (DOCKET-50260-29; DOCKET-50296-28). Dep. NTIS.

Revised design parameters of the Browns Ferry Power Reactor Units 1, 2, and 3 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

3713 (DOCKET-50259-31) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. Discussions and Findings by the Division of Reactor Licensing Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 24 Nov 1971. 22p. (DOCKET-50260-30; DOCKET-50296-29). Dep. NTIS.

3714 (DOCKET-50263-91) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Discussion and Findings by the Division of Reactor Licensing Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 19 Nov 1971. 38p. Dep. NTIS.

3715 (DOCKET-50271-65) VERMONT YANKEE NUCLEAR POWER STATION. Technical Specifications, Proposed Release Limits for Radioactivity in Gaseous Effluents. (Vermont Yankee Nuclear Power Corp., Rutland). 11 Nov 1971. 2p. Dep. NTIS.

3716 (DOCKET-50275-18) DIABLO CANYON NUCLEAR POWER PLANT, UNITS 1 AND 2. Environmental Report, Supplement No. 1. (Pacific Gas and Electric Co., San Francisco, Calif.). 9 Nov 1971. 76p. (DOCKET-50323-16). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Environmental aspects of transmission lines are described. (D.C.C.)

3717 (DOCKET-50275-19) DIABLO CANYON NUCLEAR POWER PLANT, UNITS 1 AND 2. Statement Why Construction Permit Should Not Be Suspended Pending Completion of NEPA Environmental Review, Supplement No. 2. (Pacific Gas and Electric Co., San Francisco, Calif.). 24 Nov 1971. 5p. (DOCKET-50323-17). Dep. NTIS.

3718 (DOCKET-50277-28) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Discussion and Findings by Division of Reactor Licensing Relating to Consideration of Suspension Pending NEPA Environmental Review of the Construction Permits. (Division of Reactor Licensing (AEC), Washington, D. C.). 23 Nov 1971. 28p. (DOCKET-50278-28). Dep. NTIS.

3719 (DOCKET-50282-44) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment No. 12. (Northern States Power Co., Minneapolis, Minn.). 19 Nov 1971. 792p. (DOCKET-50306-43). Dep. NTIS.

Revised design parameters of the Prairie Island Power Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

3720 (DOCKET-50285-51) FORT CALHOUN STATION, UNIT NO. 1. Final Safety Analysis Report, Amendment No. 29. (Omaha Public Power District, Nebr.). 18 Nov 1971. 154p. Dep. NTIS.

Revised and additional information is presented concerning design parameters and operations aspects of the reactor. (D.C.C.)

3721 (DOCKET-50293-58) PILGRIM NUCLEAR POWER STATION. Environmental Report Supplement, Operating License Stage; Environmental Aspects of New Transmission Lines. (Boston Edison Co., Mass.). 8 Nov 1971. 6p. Dep. NTIS.

3722 (DOCKET-50293-59) PILGRIM NUCLEAR POWER STATION. Environmental Report Supplement, Operating License Stage; Radiological Environmental Effects. (Boston Edison Co., Mass.). 8 Nov 1971. 40p. Dep. NTIS.

Information concerning radioactive discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

3723 (DOCKET-50293-60) PILGRIM NUCLEAR POWER STATION. Environmental Report Supplement, Operating License Stage; Alternatives Associated with the Operation of Pilgrim Station and Cost/Benefit Considerations. (Boston Edison Co., Mass.). 8 Nov 1971. 146p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

3724 (DOCKET-50293-61) PILGRIM NUCLEAR POWER STATION. Errata to Environmental Report Supplements. (Boston Edison Co., Mass.). 24 Nov 1971. 7p. Dep. NTIS.

Corrected information is presented concerning thermal discharges from the reactor. (D.C.C.)

3725 (DOCKET-50298-24) COOPER NUCLEAR STATION. Environmental Report, Operating License Stage, Supplement. (Nebraska Public Power District, Columbus). 8 Nov 1971. 97p. Dep. NTIS.

Information concerning radioactive discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

3726 (DOCKET-50301-44) POINT BEACH NUCLEAR PLANT, UNIT 2. Ruling by Atomic Safety and Licensing Appeal Board. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Power Co., Appleton, Wis.). 8 Jul 1971. 17p. Dep. NTIS.

3727 (DOCKET-50301-45) POINT BEACH NUCLEAR PLANT, UNIT NO. 2. Facility Operating License No. DPR-27

with Technical Specifications. (Division of Reactor Licensing (AEC), Washington, D. C.). 16 Nov 1971. 196p. Dep. NTIS.

3728 (DOCKET-50302-27) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Final Safety Analysis Report, Amendment No. 14. (Florida Power Corp., St. Petersburg). 9 Nov 1971. 239p. Dep. NTIS.

An evaluation of purging as a means of controlling post-accident hydrogen accumulation is presented. Meteorological data for the reactor site are included. Technical specifications are presented. (D.C.C.)

3729 (DOCKET-50302-28) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Final Safety Analysis Report, Amendment 15; Statement Why Construction Should Not Be Suspended Pending Completion of the NEPA Environmental Review, Supplement. (Florida Power Corp., St. Petersburg). 9 Nov 1971. 23p. Dep. NTIS.

3730 (DOCKET-50302-29) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Environmental Status Report, April-June 1971. (Florida Power Corp., St. Petersburg). 10 Nov 1971. 118p. Dep. NTIS.

Limnological and meteorological data recorded for the reactor site during April to June 1971 are presented. Radiation monitoring data for the site are also included. (D.C.C.)

3731 (DOCKET-50305-29) KEWAUNEE NUCLEAR POWER PLANT. Final Safety Analysis Report, Amendment No. 12. (Wisconsin Public Service Corp., Green Bay). 8 Nov 1971. 511p. Dep. NTIS.

Revised design parameters of the Kewaunee Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

3732 (DOCKET-50312-28) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Environmental Report, Amendment 1. (Sacramento Municipal Utility District, Calif.). 10 Nov 1971. 224p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

3733 (DOCKET-50315-53) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Environmental Report, Supplement. (Indiana and Michigan Power Co., New York). 8 Nov 1971. 384p. (DOCKET-50316-53). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

3734 (DOCKET-50321-27) EDWIN I. HATCH NUCLEAR PLANT, UNITS 1 AND 2. Environmental Report, Construction Permit Stage, Supplement. (Georgia Power Co., Atlanta). 5 Nov 1971. 343p. (DOCKET-50366-19). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

3735 (DOCKET-50324-25) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Statement Why Construction Permit Should Not Be Suspended Pending Completion of NEPA Environmental Review, Additional Information. (Carolina Power and Light Co., Raleigh, N. C.). 11 Nov 1971. 7p. (DOCKET-50325-25). Dep. NTIS.

3736 (DOCKET-50324-26) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Discussion and Findings by the Division of Reactor Licensing Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 19 Nov 1971. 32p. (DOCKET-50325-26). Dep. NTIS.

3737 (DOCKET-50331-30) DUANE ARNOLD ENERGY CENTER. Environmental Report, Revised November 1971. (Iowa Electric Light and Power Co., Cedar Rapids). 15 Nov 1971. 376p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

3738 (DOCKET-50333-34) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Final Safety Analysis Report, Amendment No. 2. (Power Authority of the State of New York). 8 Nov 1971. 170p. Dep. NTIS.

Revised and additional information is presented concerning design parameters and operations aspects of the reactor. (D.C.C.)

3739 (DOCKET-50336-25) MILLSTONE NUCLEAR POWER STATION, UNIT 2. Environmental Report, Construction Permit Stage. (Millstone Point Co., Hartford, Conn.). 29 Nov 1971. 417p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Geological, hydrological, and meteorological data for the reactor site are included. (D.C.C.)

3740 (DOCKET-50366-20) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment No. 13. (Georgia Power Co., Atlanta). 12 Nov 1971. 16p. Dep. NTIS.

Hydrological data for the reactor site are presented. Additional information concerning the residual heat removal service water system is included. (D.C.C.)

3741 (DOCKET-50397-9) HANFORD NO. 2 NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, Amendment No. 1. (Washington Public Power Supply System, Kennewick). 14 Oct 1971. 185p. Dep. NTIS.

Revised design parameters of the Hanford Power Reactor Unit 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

3742 (SZS-5/71) ESTABLISHMENT OF SPECIAL RADIATION PROTECTION NORMS FOR NUCLEAR POWER PLANTS IN THE GERMAN DEMOCRATIC REPUBLIC. Burkhardt, W.; Strauss, H.; Muenchow, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Mar 1971. 18p. (In German). Dep. NTIS (U. S. Sales Only).

With increasing use of nuclear energy for electric power supply the maximum permissible dose equivalents that have been legally set do not warrant a sufficient limitation of the radiation risk of the population as a whole. Therefore special radiation protection norms are given for the G.D.R. which are independent on the site of the nuclear power plant and refer to electricity production. Deriving these norms for the foreseeable increase of electricity production, the number of inhabitants of the country and dose limits for limitation of genetic and somatic damages by ionizing radiations were taken into account. These special radiation protection norms are useful to those responsible for the design, construction and operation of nuclear power plants since from these norms they can directly derive quantitative requests on the plant safety and the reliability and efficiency of protective and safety measures for normal operation as well as accidental situations. 17 references. (auth)

3743 HYDROGRAPHICAL INVESTIGATIONS OFF THE COAST OF BARSEBAECK. Waendahl, Tomas; Bergstrand, Erland (Sveriges Meteorologiska och Hydrologiska Institut, Stockholm). pp 71-90 of Oeresundsvattenkommittens Undersoekningar 1965-1970. Stockholm; Allmaenna Foerlaget (1971). (In Swedish).

The hydrographical characteristics of the environment of Barsebaeck, 16 Km north of Malmoe where a nuclear power plant is planned, are examined. Parameters such as currents, water temperatures and salinities have been measured by the Swedish Meteorological and Hydrological Institute. The Institute has also estimated the dispersion and the mixing of the discharged cooling water. The results show that at a station at 5 m depth upcoast currents were especially predominant. (auth) (Sweden)

3744 SEQUOYAH NUCLEAR POWER PLANT: SITE AND CONSTRUCTION. Weaver, D. B.; Dilworth, G. F. (Tennessee Valley Authority, Knoxville). Nucl. Eng. Int.; 16: No. 185, 845-9(Oct 1971).

The Sequoyah plant, under construction on the west shore of the Chickamauga reservoir, 18 m N.E. of Chattanooga, is a 2441 MW(e) plant consisting of two light water reactors. The background to the project and the advantages of the situation, particularly with regard to water supply and waste disposal, are discussed. Descriptions are given of the geology of the site, the structure of the main buildings, and the progress of construction. (UK)

3745 NUCLEAR POWER ON THE GREAT LAKES: RADIOACTIVE AND THERMAL CONSIDERATIONS. Gustafson, Philip F. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 454(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3746 MODEL RELATING NUCLEAR POWER INDUSTRY GROWTH TO REGIONAL DOSE. Fletcher, J. F.; Haffner, D. R.; Black, W. E. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 457(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3747 MODELING OF RADIONUCLIDE RELEASES FROM NUCLEAR POWER AND REPROCESSING PLANTS. Wise, K. R.; Bentley, B. W. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 457-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3748 NUCLEAR POWER WASTE HEAT REJECTION IN ARID AREAS. Scofield, Frederic C. (Omaha Public Power District, Neb.); Fazzalore, Rocco A. Trans. Amer. Nucl. Soc.; 14: No. 2, 466-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3749 PLOWSHARE AND NUCLEAR POWER PLANT SITING. Lahoud, J. A.; Orphal, D. L. (Environmental Research Corp., Las Vegas, Nev.). Trans. Amer. Nucl. Soc.; 14: No. 2, 713-14(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3750 PILOT STUDY OF PUBLIC OPINION REGARDING THE SHOREHAM PLANT. Beller, Morris (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 759(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3751 FLEXIBILITY IN A GASEOUS RADWASTE SEPARATION PROCESS FOR POWER REACTORS. Feibush, Arthur M. (Airco/BOC Cryogenic Plants Corp., Murray Hill, N. J.). Trans. Amer. Nucl. Soc.; 14: No. 2, 774(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3752 FACTORS AFFECTING THE CHOICE OF LOCATION FOR NUCLEAR POWER PLANTS, PARTICULARLY IN SOUTH AND WEST FINLAND. Jahkola, A. (Imatran Voima Osakeyhtioe, Helsinki). Sahko; 44: No. 5-6, 138-42(May-Jun 1971). (In Finnish).

Finland's nuclear power demand up to the year 2000, its regional siting and general factors affecting the choice of sites are described. (auth) (FINLAND)

Steam and Power Conversion Systems

3753 SEQUOYAH TURBO-GENERATOR AND ELECTRICAL SYSTEM. Weaver, D. B. Nucl. Eng. Int.; 16: No. 185, 868-9 (Oct 1971).

The turbo-generator is a six-flow, 44-in. unit with seven stages of extraction. Boiler feed pumps are turbine driven with the turbine condenser serving as a feedwater heater. Dual engine diesel generators serve as back-up for plant electrical requirements. (auth)

Power Reactor Development

Refer also to abstract 1999.

3754 (ANL-7861) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, SEPTEMBER 1971. (Argonne National Lab., Ill.). 26 Oct 1971. Contract W-31-109-eng-38. 169p. Dep. NTIS.

Highlights of project activities for September 1971 are summarized. The Experimental Breeder Reactor-II operations, fuels and materials studies, and engineering development are reported. Heat transfer and fluid flow in LMFBR cores were studied. The development of instrumentation for sodium cooled reactors was continued. Sodium monitoring and sampling systems for the Fast Flux Test Facility and LMFBR systems are described. LMFBR fuels and materials development and fuel cycle studies are examined. Zero Power Reactor fast critical experiments and LMFBR safety studies are summarized. Thermal plume dispersion and power plant siting on Lake Michigan were studied. (H.D.R.)

3755 (EURFNR-913) REPORT ON THE RESEARCH AND DEVELOPMENT ON THE STEAM-COOLED FAST BREEDER CONDUCTED AT KARLSRUHE NUCLEAR RESEARCH CENTER. Engelmann, P.; Erbacher, F.; Garsten, G.; Ritz, L. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Translation of report KFK-1370. 228p. Dep. NTIS.

Work performed under United States-Euratom Fast Reactor Exchange Program.

A review on work conducted on the steam-cooled fast breeder reactor within the Fast Breeder Project from 1961 until 1970 is presented. Based on the results described and by comparison with the situation encountered in the development of fast breeders with sodium and helium cooling, an evaluation of the present situation is given and recommendations are provided for future action. (auth)

3756 (EURFNR-940) TECHNICAL AND ECONOMIC STATUS AND FUTURE OUTLOOK FOR NUCLEAR ENERGY IN THE WEST GERMAN POWER INDUSTRY. PART II. STUDY CONDUCTED ON BEHALF OF THE WEST GERMAN MINISTRY FOR EDUCATION AND SCIENCE. Haefele, W.; Kraemer, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung. Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Translation of report JUL-775-RG; KFK-1430. 99p. Dep. NTIS.

Work performed under United States-Euratom Fast Reactor Exchange Program.

An account of the present situation of the advanced reactor types now being developed in the Federal Republic of Germany is presented. The high-temperature gas-cooled reactor and the sodium-cooled fast breeder reactor projects are described. 61 references. (auth)

3757 (GA-10509) PHYSICS DESIGN OF THE GAS-COOLED FAST BREEDER REACTOR DEMONSTRATION PLANT. Pellaud, Bruno (Gulf General Atomic Co., San Diego, Calif.). 29 Aug 1971. Contract AT(04-3)-167. 186p. Dep. NTIS.

The reactor physics work related to the Gas Cooled Fast Reactor Demonstration Plant is reviewed. Special attention is devoted to control rods, fuel management, and blanket design. A complete description of studies related to static and burnup behavior, reactivity coefficients, and reactor kinetics is supplied. A major section on basic data gives special attention to the cross section of Pu-239, Pu-240, and U-238. Methods for calculating neutron spectra and streaming effects are described. 72 references. (auth)

3758 (NP-19054) O.E.C.D. HIGH TEMPERATURE REACTOR PROJECT DRAGON TWELFTH ANNUAL REPORT, 1970-1971. (Organization for Economic Co-Operation and Development, Paris (France)). 143p. Dep. NTIS (U. S. Sales Only).

Highlights of the Dragon reactor project for the period April 1, 1970 to March 31, 1971 are presented. Principal activities summarized include: reactor operation; fuels and graphite irradiation and development; reactor physics and engineering; technical services; and administration. (H.D.R.)

3759 POPULATION BALANCE MODELS TO INVESTIGATE THE FLOW CHARACTERISTICS OF THE FUEL ELEMENTS IN THE CORE OF A PEBBLE-BED REACTOR WITH ONE OR SEVERAL OUTLETS. Bedenig, D. Aufbereitungs-Tech.; No. 8, 474-9(1970). (In German).

"Population Balance Models" can be used to describe the flow of bulk materials through vessels. These models correlate the output function of a test material with its input providing information on the flow characteristics of the material within the vessel. The application of such models as well as various experimentally determinable functions to characterize the material flow are described. These characteristic functions are discussed using the flow of a pebble bed through the core of a high-temperature reactor with several outlets as an example. 8 references. (auth)

3760 REFUELLING TUBE IN A WATER-COOLED NUCLEAR REACTOR. Wadmark, Lars Olof Tor (to Aktienbolaget Atomenergi). U. S. Patent 3,607,628. 21 Sep 1971. Priority date 3 Dec 1965, Sweden.

In a water-cooled nuclear reactor, fuel is introduced into the interior of the reactor vessel through a refuelling tube which extends through a water-filled portion of the reactor core. The cooling of the refuelling tube is made possible by the provision of openings in the tube below the reactor core and above the reactor core whereby heat produced by a fuel cartridge when passing through the tube induces a flow of water through the tube. (auth)

3761 250MW(e) PROTOTYPE FAST REACTOR AT DOUNREAY-1. Steam Heat. Eng.; 41: No. 479, 6-12(Oct 1971).

The purpose of the PFR is discussed. Illustrated descriptions are given of the station, site layout, and core structure, with details of the primary circuit, including heat exchangers and pumps. (UK)

3762 IMPROVEMENTS IN OR RELATING TO LIQUID METAL COOLED FAST BREEDER NUCLEAR REACTORS. Jackson, George Oliver (to United Kingdom Atomic Energy Authority). British Patent 1,249,331. 13 Oct 1971. Filed 30 Jan 1968.

The reactor system described provides an optimised design for large power-producing reactors. The reactor has radial and upper-end neutron shields, and its coolant circuitry is submerged in a liquid metal pool in a tank located in a vault. The core is enclosed and the core and radial neutron shield are contained in an open-topped vessel, closable by a lid incorporating a portion of the upper-end neutron shield, the remaining portion of this shield being constituted by the vault roof. There are a number of coolant circuit loops, each comprising outflow ducts penetrating the open-topped vessel at the upper end, and in-flow ducts penetrating the vessel at the lower end. Heat exchange means and liquid metal circulating means are provided between the outflow and inflow ducts. The vault roof preferably includes a part rotatable relative to the core and having one location where it is co-axial with the core, and the lid of the open-topped vessel is connected to the rotatable part. This lid may also be employed to support equipment associated with the core. At least one manually operable valve should be provided for joining each coolant circuit loop to the liquid metal pool so as to provide a heat sink for decay heat from the reactor core in the event of failure of the coolant circulating means. (UK)

3763 SIMULATOR OF THE PHENIX POWER PLANT. Fourcade, C. (CEN de Cadarache, Saint-Paul-les-Durance, France). Bull. Instrum. Nucl.: No. 43, 37-8(Mar 1971). (In French).

This simulator, installed at Cadarache, is intended to familiarize operators with the dynamic behavior and the startup and shutdown procedures of the plant. The requirements sought were maximum simplicity, reliability and a capability of simulating the low transients of the power plant. This simulator consists of an E.A.I. 8945 hybrid unit and a control desk for monitoring the control rods of the primary and secondary coolant loops, the emergency shutdowns, and the water flow rate in the vapor generator. (France)

3764 TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY 1971 WINTER MEETING, OCTOBER 17-21, 1971, MIAMI BEACH, FLORIDA. Farmakes, Ruth (ed.). Trans. Amer. Nucl. Soc.; 14: No. 2, 421-940(2 Oct 1971). (CONF-711009).

Included are summaries of 572 papers covering all aspects of nuclear technology. Each paper is title listed in NSA. (H.D.R.)

For abstracts of individual papers see: 1779–1786, 1795, 1796, 1802–1809, 1817–1819, 1850, 1893, 1917, 1930, 1943–1954, 1977–1979, 1983, 1991–1996, 1999, 2007–2027, 2037–2045, 2056–2071, 2086–2112, 2120–2137, 2159–2189, 2242–2250, 2279–2284, 2319, 2320, 2340–2347, 2359, 2360, 2381, 2389, 2394–2400, 2405, 2409, 2410, 2426, 2460–2463, 2479–2481, 2506–2515, 2543, 2554–2574, 2579, 2580, 2595–2598, 2618–2622, 2634, 2639–2649, 2655, 2772, 2851, 2852, 2979, 3009, 3037–3040, 3078–3090, 3092–3098, 3131, 3132, 3494, 3513–3533, 3567–3573, 3623–3630, 3661–3665, 3675–3678, 3690–3695, 3745–3751, 3765–3772, 3779–3807, 3813–3816, 3818–3820, 3832–3846, 3857–3868, 3876–3880, 3886–3893, 3903–3932, 3938, 3955–3992, 3997–4013, 4016–4030, 4039–4054, 4057, 4058, 4062–4064, 4088–4090.

3765 NUCLEAR ENERGY FOR THE HOMEMAKER: NUCLEAR POWER. Carter, Robert L. (Univ. of Missouri, Columbia). Trans. Amer. Nucl. Soc.; 14: No. 2, 451(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3766 NONDESTRUCTIVE EXAMINATION OF HIGH-FLUENCE EBR-II THIMBLES. Phipps, R. D. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: No. 2, 601(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3767 ANALYSES OF EBR-II CORE-COMPONENT DEFORMATIONS. Bump, T. R. (Argonne National Lab., Ill.); McGinnis, F. D.; Phipps, R. D.; Strain, R. V. Trans. Amer. Nucl. Soc.; 14: No. 2, 601-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3768 REACTOR IN-CORE TEMPERATURE MONITOR. Franklin, D. G. (Argonne National Lab., Idaho Falls, Idaho); Ruther, W. E. Trans. Amer. Nucl. Soc.; 14: No. 2, 632-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3769 GASEOUS CORE REACTOR WITH MHD CONVERSION FOR ELECTRICAL POWER GENERATION. Williams, J. Richard (Georgia Inst. of Tech., Atlanta); Rosa, Richard J. Trans. Amer. Nucl. Soc.; 14: No. 2, 711-12(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3770 CORE DESIGN OF CE LMFBR DEMONSTRATION PLANT. Menzel, G.; Caspersson, S. A.; Noyes, R. C. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 714(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3771 LMFBR CORE DESIGN FOR SWELLING ACCOMMODATION. Burchill, W. E.; Menzel, G.; Noyes, R. C.; Dupen, C. F. G. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 714-15(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3772 NUCLEAR DESIGN OF THE WESTINGHOUSE 300-MW(e) LMFBR DEMONSTRATION PLANT. Dyos, M. W. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 715-16(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Kinetics and Dynamics

Refer also to abstracts 3941 and 3947.

3773 (DP-MS-71-49) RESPONSE OF A LARGE NUCLEAR REACTOR TO AN OSCILLATING SOURCE PERTURBATION. Olson, Robert Linwood (Du Pont de Nemours (E.I.) and Co., Aiken, S. C. Savannah River Lab.). Aug 1971. 158p. Dep. NTIS.

Thesis. Submitted to Univ. of Tenn., [Knoxville].

The objectives of this investigation were to investigate experimentally spatial effects on the response of a large nuclear reactor to a source oscillation, and the effects of a reflector on the response of a nuclear reactor to a source oscillation. These objectives were accomplished by observing the output signals of neutron detectors in a large cylindrical nuclear reactor with an oscillating fast-neutron source. The oscillating source was placed at the vertical midplane of the reactor at several horizontal locations, and the neutron detectors were placed along an axially-centered diameter of the reactor. Data were taken for both reflected and non-reflected radial boundary conditions for oscillation frequencies from one-tenth Hertz to sixty Hertz. Reference signals produced by a sine-cosine generator coupled to the oscillator were used to electronically Fourier-analyze the neutron detector output signals. The reactor response was found to exhibit large deviations from that predicted by the space-independent model. The reactor response predicted by a time-dependent diffusion theory computer code agreed well with the experimental data for those cases in which the code was an accurate model. The existence of propating macroscopic neutron waves was confirmed. (21 references) (auth)

3774 (EURFNR-952) THREE-DIMENSIONAL SYNTHESIS METHOD TESTED AND APPLIED IN FAST BREEDERS. Pilate, S.; Buckel, G.; Billaux, M.; Charlier, A.; McGrath, P.; Plum, F. (Kernforschungszentrum, Karlsruhe (West Germany)). Aug 1971. 62p. (KFK-1345). Dep. NTIS (U. S. Sales Only).

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The computer program KASY, written at Karlsruhe for the IBM 360/65, solves the three-dimensional diffusion equation by means of a synthesis method using available two-dimensional trial functions. The test of the flux synthesis method used in KASY with respect to results obtained by a direct three-dimensional program is described. The results considered are: k_{eff}, control rod reactivities, flux and reaction rate maps. The KASY synthesis is applied to the evaluation of a diversified series of control rod experiments in a fast breeder core containing one or more control rods. 10 references. (auth)

3775 (JUL-771-RG) NEUTRON PHYSICS OF THE PEBBLE-BED REACTOR. Froehling, Werner (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Jun 1971. 71p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

The program MUPOMINOTAUR is described for the calculation of boundary conditions of absorber zones in diffusion regions. The

application of the program considers first the reactivity of absorber rods of the AVR reactor. The three-dimensional problems of the inserted absorber-rod bank is transformed by the ring model into a two-dimensional one. Values were calculated for different burnup conditions of the core, and they are in good accordance with the measured values. For some HTR cores the mutual interdependence of control rods, the reactivity worth versus insertion depth, and the influence of the rod diameter are studied. For a global characterization of absorber rod systems in HTR cores, the term "absorber surface density A" is proposed. The connection between A and shutdown reactivity ρ is already available for some HTR reactors, and therefore can be used for the estimation of the required number of control rods for new core designs. A program is described for considering local variation in temperature and buckling by dividing the reactor core into an optional number of spectral zones. Investigation of the influence of local-dependent spectrum calculations by the example of the AVR reactor is studied. It is shown that the local dependence of the buckling is of little importance compared to that of temperature. The influence of spectral zones to the calculation of k_{eff}, of power density distribution, temperature distribution, and burnup behavior is discussed. The program also calculates the temperature coefficient. Such a calculation has been performed for the primary core of the AVR; the results show good accordance with the measured values. 17 references. (auth)

3776 REACTOR PHYSICS HETEROGENEOUS METHODS DEVELOPED AT CISE. PART 2. Bruschi, C.; Caimmi, G. F.; Fava, L.; Goldaniga, G. (CISE, Milan). Energ. Nucl. (Milan); 18: No. 10, 515-30(Oct 1971).

The calculation of the i-group bidimensional finite medium convolution fluxes and the calculation of the eigenvalue and fluxes in the CIRENE reactor are discussed. (auth)

3777 SEMINOLE: A PROGRAM FOR CALCULATING THE TWO-GROUP NUCLEAR COEFFICIENTS OF AN AXIAL REFLECTOR. Bruschio, G.; Goldaniga, G. (CISE, Milan). Energ. Nucl. (Milan); 18: No. 10, 531-40(Oct 1971). (In Italian).

The SEMINOLE program calculates the nuclear coefficients (macroscopic cross-sections, diffusion coefficients) of an axial reflector of a CIRENE reactor. Such a reflector has a heterogeneous structure: consequently the definition of the nuclear constants of the reflector assumed to be homogeneous requires the evaluation of suitable values of the ratios between the channel and moderator mean fluxes and the cell mean flux. Such evaluation is performed implicitly by applying the admittance method. (auth)

3778 EFFECT OF SPACE DEPENDENCY ON THE NEUTRON SPECTRUM WITHIN AN HTR CORE. Froehling, W. (Kernforschungsanlage, Juelich, Ger.). Atomwirt., Atomtech.; 16: No. 10, 529-30(Oct 1971). (In German).

The multigroup diffusion-depletion program in two dimensions, EREBUS, was extended in such a way that certain regions of the reactor could be conceived as separate spectral zones of neutrons for which the spectrum could be calculated individually. The studies were based on the core of the AVR reactor in Juelich. With the exception of an addition of boron to the center, the core was charged homogeneously. The reflector was subdivided into as many as 23 zones. (H.B.G.)

3779 ANALYSIS OF URANIUM AND MIXED OXIDES SALT AND PEPPER EXPERIMENTS. Doshi, P. K.; Tomonto, J. R. (Gulf United Nuclear Fuels Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 474-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3780 FEW-GROUP APPROXIMATIONS FOR TRANSIENTS IN COMMERCIAL POWER REACTORS. Denning, R. S. Trans. Amer. Nucl. Soc.; 14: No. 2, 644-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3781 CONSEQUENCES OF ASYMMETRIC COLD WATER ADDITION TO A PWR CORE FROM AN INACTIVE LOOP. Salah, S.; Rossi, C. E.; Geets, J. M. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc.; 14: No. 2, 756-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3782 NEED FOR BENCHMARK TESTS. Hannum, W. H.; Hemmig, P. B.; Lewellen, J. W.; Wiener, M. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 797(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3783 INTEGRAL MEASUREMENTS FOR FAST REACTOR CROSS SECTIONS. Scoville, J. J. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc.; 14: No. 2, 797-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3784 REVIEW OF CSEWG FAST REACTOR BENCHMARK TESTING. Alter, Harry (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 798-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3785 SENSITIVITY OF RESULTS TO CALCULATIONAL MODEL REPRESENTATIONS IN ENDF/B BENCHMARK TESTING. Palmer, R. G. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: No. 2, 799(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3786 TESTS OF ENDF/B AND MODIFIED ENDF/B DATA AGAINST INTEGRAL EXPERIMENTS. Pitterle, T. A.; Paik, N. C.; Durston, C. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 799-801(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3787 CALCULATIONS OF ENDF/B FAST REACTOR BENCHMARK CASES USING THE LASL-TD CROSS-SECTION LIBRARY. Hirons, Thomas J. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 813-14(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3788 NEW EVALUATION OF DELAYED-NEUTRON DATA FOR FAST REACTOR ANALYSIS. Cahalan, J. E.; Ott, K. O. (Purdue Univ., Lafayette, Ind.). Trans. Amer. Nucl. Soc.; 14: No. 2, 818-19(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3789 ANALYSIS OF OAK RIDGE ^{235}U-H_2O SPHERES. Mendelson, M. R. (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 826(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3790 USE OF THERMAL-NEUTRON SCATTERING LAW IN MONTE CARLO CALCULATIONS. Morrison, G. W.; Petrie, L. M.; Carlsmith, R. S. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 827(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3791 CALCULATIONS OF SEVERAL ^{238}U THERMAL SYSTEMS BY MONTE CARLO USING ENDF/B MATERIAL 103. Petrie, L. M.; Morrison, G. W. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 827-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3792 REACTIVITY EFFECT OF PuO_2 PARTICULATE FUEL. Newman, Darrell F. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 828-30(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3793 ALBEDO MODELS FOR NODAL REACTOR SIMULATION. Becker, Martin (Gulf United Nuclear Fuels Corp., Elmsford, N. Y. Rennselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 832-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3794 APPLICATIONS OF NEUTRON SPECTRA IN THE DEMONSTRATION BENCHMARK. Simons, G. G.; Palmer, R. G.; Olson, A. P. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: No. 2, 834-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3795 SIMPLE FOIL METHOD FOR LMFBR SPECTRUM DETERMINATION. Leung, T. C.; Driscoll, M. J. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc.; 14: No. 2, 841(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3796 EXPERIMENTAL STUDIES IN THREE CORE ENVIRONMENTS OF A LARGE, PuO_2-FUELED LMFBR-TYPE CRITICAL ASSEMBLY. Bohn, E. M.; LeSage, L. G. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 842-3 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3797 NOISE ANALYSIS IN POWER REACTORS. Hanauer, S. H. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 853-4(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3798 OBSERVATION OF COUPLED-CORE CHARACTERISTICS BY NOISE-MEASUREMENT TECHNIQUES. Donofsky, R. A. (Iowa State Univ., Ames). Trans. Amer. Nucl. Soc.; 14: No. 2, 855-6(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3799 CALCULATION OF REACTOR NOISE SPECTRA USING A SPACE-ENERGY-DEPENDENT MODEL: COMPARISON WITH EXPERIMENT. Robinson, J. C. (Univ. of Tennessee, Knoxville); Alexander, M. L. Trans. Amer. Nucl. Soc.; 14: No. 2, 856-7(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3800 APPLICATION OF TRANSPORT THEORY KINETICS TO THE INTERPRETATION OF EXPERIMENTAL NEUTRON NOISE SPECTRA IN LARGE FAST REACTORS. Buhl, A. R. (Oak Ridge National Lab., Tenn.); Ackermann, N. J. Jr.; Robinson, J. C. Trans. Amer. Nucl. Soc.; 14: No. 2, 857-8(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3801 EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF SPACE AND REFLECTION ON THE COUNT-RATE FLUCTUATION SPECTRA OF A LARGE NUCLEAR REACTOR. Thomas, C. O. Jr. (Tennessee Valley Authority, Knoxville); Hanauer, S. H.; Baumann, N. P. Trans. Amer. Nucl. Soc.; 14: No. 2, 858 (Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3802 COHERENCE FUNCTION ANALYSIS IN COUPLED CORES USING MODAL EXPANSIONS. Ebert, D. D. (Georgia Institute of Technology, Atlanta); Clement, J. D.; Stacey, W. M. Jr. Trans. Amer. Nucl. Soc.; 14: No. 2, 858-60(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3803 POLARITY SPECTRAL ANALYSIS REACTIVITY MEASUREMENTS IN THERMAL REACTORS. Hess, George M.; Albrecht, Robert W. (Univ. of Washington, Seattle). Trans. Amer. Nucl. Sc.; 14: No. 2, 861-2(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3804 LOCAL POWER MEASUREMENTS USING GAMMA-RAY NOISE. LeVert, F. E. (Tuskegee Inst., Ala.); Schultz, M. A. Trans. Amer. Nucl. Soc.; 14: No. 2, 862-3(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3805 NUCLEAR NOISE MONITORING FOR CORE VIBRATION SURVEILLANCE. Gopal, R.; Carteus, M. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc.; 14: No. 2, 863(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3806 ANALYSIS OF SUBCRITICAL REACTIVITY MEASUREMENTS USING PULSED-NEUTRON TECHNIQUES FOR FAST REACTORS. Kato, W. Y.; Meneley, D. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 863-4(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3807 NEUTRON WAVES IN A REFLECTED REACTOR. Shani, G. (Univ. of Negev, Beer Sheva, Israel); Cady, K. B. Trans. Amer. Nucl. Soc.; 14: No. 2, 866-7(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Control Systems

Refer also to abstracts 2326 and 3935.

3808 NUCLEAR INSTRUMENTATION SYSTEM FOR PRESSURIZED WATER REACTORS. Kawashima, Katsuhiko (Mitsubishi Electric Corp., Amagasaki, Japan); Kichishima, Uichi. Mitsubishi Denki Giho; 45: No. 3, 368-72(Mar 1971). (In Japanese).

Although pressurized water reactors (PWR) are controlled by measurement of inlet and outlet temperatures of cores, it is not adequate because of time lag, so that information of neutron flux obtained from the nuclear instrumentation system is also used. The nuclear instrumentation system includes both in-core and ex-core instrumentation, and the latter is described. Since the whole neutron flux range can not be covered with a single system, it is divided into three parts: source; intermediate; and power ranges. Measurement is practiced by overlapping partly in each range. In PWRs, the number of channels in each range is determined as: source range 2; intermediate range 2; and power range 4. After details of each channel are described, the perspective of variation of the system with increasing reactor size is given. For example, it is considered that importance of the in-core instrumentation becomes larger. (Japan)

3809 DRIVE MECHANISM FOR CONTROL ELEMENTS. Frisch, Erling; Andrews, Harry N. (to Westinghouse Electric Corp.). U. S. Patent 3,607,629. 21 Sep 1971. Filed 24 Jan 1968.

A nuclear reactor is disclosed wherein hydraulic drive mechanisms are provided to vary the location of a plurality of neutron-absorbing control elements associated with selected fuel assemblies. Each fuel assembly comprises a fixed array of commingled and spaced fuel pins and guide tubes. Each selected assembly has a plurality of individually movable two-position control elements which are coupled to drive mechanisms which operate to telescope the control elements within their associated guide tubes. (auth)

3810 PROCESS COMPUTERS FOR NUCLEAR POWER PLANTS. Freymeyer, Ph. (Kraftwerk Union AG, Erlangen, Ger.). Atomwirt., Atomtech.; 16: No. 10, 524-8(Oct 1971). (In German).

The automatization technique of power plants has a history of about 10 years in West Germany. During that time, experience was gained on about 150 conventional and nuclear power plants that were equipped with various types of automatic control systems. The process computer became the most reliable tool for data evaluation. The concept of automatization is described as are the various functions of process computers as presently applied in German power plants. (H.B.G.)

3811 DEVELOPMENT TENDENCY FOR UTILIZATION OF PROCESS COMPUTERS IN NUCLEAR POWER PLANTS. Hoermann, H. (Institut fuer Mess- und Regelungstechnik, Garching, Ger.). Atomwirt., Atomtech.; 16: No. 10, 520-3(Oct 1971). (In German).

In West Germany, all large power plants, presently in the planning or construction stage, include process computers. Computers play such a significant role that, in the case of computer failure, certain plant operations must be restricted. At the present time, computers directly affect processes only to a limited degree. Predominantly, they serve as storage for information and as centers for monitoring. Possibilities of the computer, even without direct influence, are not exhausted as yet. With respect to direct influence, the tendency aims at removal of guidance and control systems from the central process computer into several small computer units. (tr-auth)

3812 MEASUREMENT OF THE RESONANCE INTEGRAL OF HAFNIUM. Demmeler, M. (Institut fuer Reaktorentwicklung, Juelich, Ger.); Hecker, R.; Jonas, H.; Kleinschnittger, K.; Ramakrishna, D. V. S. Atomwirt., Atomtech.; 16: No. 10, 532-3(Oct 1971). (In German).

The resonance integral of hafnium carbide was studied on thin foils from 2.5 μm to 38 μm. The measurements yielded a resonance integral of 2280 ± 180 barn. Resonances above 10 eV contributed only about 2% to the total integral. Essentially the integral includes resonances at 7.6 eV, 2.3 eV, and 1.1 eV. The experiments were performed with respect to hafnium-containing spherical neutron absorbers for high temperature reactors. (H.B.G.)

3813 BWR CONTROL ROD WITHDRAWAL OPTIMIZATION USING DYNAMIC PROGRAMMING. Snyder, B.; Lewis, E. E. (Northwestern Univ., Evanston, Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 646(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3814 ON-LINE COMPUTATION OF SHORT-TERM POWER REACTOR RESPONSE TO OPERATIONAL TRANSIENTS. Savoia, Peter J. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 751(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3815 CONTROL SYSTEM FOR THE GAS-COOLED FAST BREEDER REACTOR PLANT. Read, J. W. (Gulf General Atomic, San Diego, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 751-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3816 TRITIUM PRODUCTION IN FAST REACTORS CONTAINING B_4C. Sehgal, B. R.; Rempert, R. H. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 779-80(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Shielding

Refer also to abstracts 3664 and 3992.

3817 (ORNL-tr-2494) SHIELDING OF FAST BREEDER REACTORS. Albrecht, L.; Gegusch, M.; Schimmel, W. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Kernenergie; 13: No. 8, 237-42(1970). 17p. Dep. NTIS.

The differences between the shielding of fast breeder reactors and of thermal reactors are due to the higher flux of fast neutrons and activation of the metallic coolant used in most cases. The criteria for shield design are more extensive than in the case of thermal reactors. The basic construction of the shield of fast breeder reactors can be classified into primary, secondary and biological shielding, which have more or less different tasks. The favored coolant is sodium, although from the point of view of shielding it is less suitable than other liquid metals also discussed. Irregularities in the shield are with fast reactors as with others a serious problem of shielding, whereby in particular, so-called material-filled cracks are to be considered. General requirements in the choice of shielding materials and in the construction of the shield are presented. (32 references) (auth)

3818 MAN-RATED SHIELD FOR THE ZIRCONIUM HYDRIDE SPACE POWER REACTOR. Soffer, L.; Connolley, D. J.; Karp, I. M. (Space Nuclear Systems Office, Cleveland). Trans. Amer. Nucl. Soc.; 14: No. 2, 437(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3819 PRESSURE VESSEL FLUENCE CALCULATIONS FOR LARGE PRESSURIZED WATER REACTORS. Sapyta, J. J.; Harwell, J. W.; Wittkopf, W. A. (Babcock and Wilcox, Lynchburg, Va.). Trans. Amer. Nucl. Soc.; 14: No. 2, 890-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3820 PROJECTED LMFBR SHIELDING NEEDS AND AEC/RDT PROGRAMS. Lewellen, J. W.; Hemmig, P. B.; Hannum, W. H. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 934(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Cooling Systems

Refer also to abstracts 1919, 2341, and 3935.

3821 (JUL-770-RG) CALCULATION OF HEAT REMOVAL THROUGH NATURAL CONVECTION IN THE STATIONARY REGION OF GAS-COOLED REACTORS WITH THE HELP OF THE COMPUTER PROGRAM "NAKOSTA." Singh, J.; Schneider, K. U. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Jun 1971. 75p. (In German). Dep. NTIS (U. S. Sales Only).

A computer program NAKOSTA (NAtural COnvection in the STAtionary Condition) was made to calculate the heat transport by natural convection with a given course of surface temperature along a defined, closed circuit. This circuit consists of a heat-supplying and a heat-removing component. These two main components are divided into some axial zones in order to determine the local coolant-temperatures with a given mass flow under consideration of the corresponding heat transfer coefficient or overall heat transfer coefficient. At the same time, the local coefficients of pressure loss and the local factors of pressure loss are calculated. An iteration procedure determines buoyancy and pressure loss along the circuit with the corresponding mass flow, and the removable heat amount per unit time. Some examples show different cooling arrangements and gases (helium, air, CO_2) and their ability to remove heat at various system pressures. This shows that with CO_2 at system pressures between 10 and 20 bar and with the application of an optimized finned transfer medium an after-heat amount of more than 1% of the thermal core power by normal operation can be removed. The same amount of after-heat could also be removed under these pressures with a tube transfer medium by using helium. The application of different fuel element types in the core, however, did not show a significant difference in after-heat removal. (12 references) (auth)

3822 (TRG-Report-2094) SODIUM INSTRUMENTATION. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1971. 27p. Dep. NTIS (U. S. Sales Only).

Seven papers on instrumentation for measurements in sodium cooled reactors and test rigs are presented. The instruments were developed as part of the Prototype Fast Reactor program. The papers include: (1) Sodium Process Instrumentation for the Dounreay PFR; (2) Sodium Flow Measurement in PFR; (3) Sodium Flow Monitoring; (4) Measurements of Sodium Level in PFR; (5) Sodium Pump Instrumentation; (6) Sodium Impurity Monitoring by Automatic Plugging Meters; and (7) Detection of Sodium-Water Leaks in PFR Secondary Heat Exchangers. (H.D.R.)

3823 EXPERIMENTAL STUDY ON MODELS OF THE OPERATING TEMPERATURE REGIMES OF THE FUEL ELEMENTS OF A BOR-60 REACTOR. Subbotin, V. I.; Zhukov, A. V.; Pashek, M.; (and others) (Inst. of Physics-Power Engineering, Obninsk, USSR). Heat Transfer Sov. Res.; 3: No. 5, 15-26(Sep Oct 1971).

The results of experimental studies of the temperature fields and heat transfer of the fuel element of a BOR reactor are given using thermal models of the core of such a reactor. An estimate is made of the temperature irregularities of the central, lateral and corner fuel elements of the assembly. 10 references. (auth)

3824 BOILING HEAVY WATER INDIRECT-CYCLE REACTOR. Fajeau, Maurice (to Commissariat a l'Energie Atomique). U. S. Patent 3,607,633. 21 Sep 1971. Priority date 5 Apr 1967, France.

The boiling heavy water reactor has heat exchangers located in the pressure vessel around a tank containing part of the heavy water inventory which constitutes the moderator. The flow of heavy water used as coolant circulates along two different paths. The first path comprises the heat exchangers, the interior of the tank and certain of the guide tubes locating the fuel elements. The second path comprises the other guide tubes. Both paths open into a collector space above the tank. (auth)

3825 PRESSURIZED NUCLEAR REACTOR WITH SIMPLIFIED ARRANGEMENT FOR DISTILLATION OF PRIMARY FLUID. Gerard, Claude J. O. L.; Lamproye, Fernand A. J. L.; Piron, Henri C. G. (to Societe Anglo-Belge Vulcain). U. S. Patent 3,607,634. 21 Sep 1971. Priority date 27 Aug 1964, Luxembourg.

A nuclear reactor is described which has a boiler for distillation of primary fluid. The internal arrangements have been simplified and the distilling operation rendered more efficient by location of the boiler in the thermal shield. (auth)

3826 NUCLEAR REACTOR WITH VARIABLE FLOW STEAM CIRCULATOR. Ripley, Charles C.; O'Neill, Gerald L. (to General Electric Co.). U. S. Patent 3,607,635. 21 Sep 1971. Filed 10 Apr 1968.

A steam cooled nuclear reactor power plant is described which has an improved thermopresser capable of part load operation. In a steam thermopresser in which water droplets are injected into flowing superheated steam, a system is provided by which water-flow can be decreased as steam flow decreases, while maintaining an optimum thermopresser throat configuration at any flow rate. (auth)

3827 NUCLEAR REACTOR COOLANT FLOW DEVICE. Marshall, Robert C. (to Combustion Engineering, Inc.). U. S. Patent 3,607,637. 21 Sep 1971. Filed 3 Jan 1969.

A flow-confining arrangement is described for a nuclear reactor which has a core comprised of a plurality of parallel fuel elements. The core is of the open type wherein the flow surrounds each of the fuel rods. A core barrel surrounds the core and generally confines the coolant flow which is passing longitudinally of the fuel elements. A plurality of seal plates extend transversely from the core barrel to the outer fuel elements of the core. These plates prevent flow through the irregular annular space between the core barrel and the core so as to avoid coolant bypassing the core. A plurality of these plates are at locations intermediate the top and bottom of the core with the spacing between these seal plates being sufficiently smaller so that the coolant flow does not expand in this flow path to flow through all the irregular annular opening. This close spacing assures that the coolant flow is effectively confined to the reactor core not only at the seal plate location but also at the locations intermediate the seal plate. The maximum spacing to perform this function is preferred to avoid the requirement of

too many seal plates. These seal plates provide a minimum of neutron-absorbing material near the outer fuel elements of the core thereby increasing the output of these fuel elements and accordingly the overall power capability of the core. (auth)

3828 MASS FLUX AND ENTHALPY DISTRIBUTION IN A ROD BUNDLE FOR SINGLE- AND TWO-PHASE FLOW CONDITIONS. Lahey, R. T. Jr.; Shiralkar, B. S.; Radcliffe, D. W. (General Electric Co., San Jose, Calif.). J. Heat Transfer; 93: No. 2, 197-209(May 1971).

Diabatic multirod subchannel data were obtained in a 9-rod bundle for operating conditions typical of a boiling water reactor. These data were used to obtain both the natural flow and enthalpy distribution in a rod bundle and information on the flow diversion enthalpy and the effective flow diversion length. (19 references) (auth)

3829 IMPROVEMENTS IN OR RELATING TO THE CIRCULATION OF COOLING GAS IN THE PRESSURE VESSEL OF A NUCLEAR-REACTOR PLANT. (to James Howden and Co. Ltd.). British Patent 1,247,844. 29 Sep 1971. Filed 12 Oct 1967.

Reference is made to gas circulators of the kind comprising a tubular housing in an opening in the pressure vessel wall, the motor being located in this housing and the blower in the pressure vessel, aligned with the associated ducting. No provision is normally made for withdrawing the blower for maintenance while allowing continued operation of the plant. In the arrangement described the housing is provided with an isolator comprising an annular seat at its inner end, together with a ring spaced axially inwards from the seat to form therewith an annular through passage surrounding the blower. An end cover is spaced axially inwards from the ring. The ring is axially removable on to the seat and the end cover on to the ring, so that the ring and end cover together enclose the blower and close the inner end of the housing. The end cover may be enclosed in a compartment connected to a low pressure zone in the blower, so that the high pressure gas keeps the end cover in open position. Axial draw rods may be provided. (UK)

3830 STEAM GENERATING NUCLEAR REACTORS. Gilbert, Charles Philip (to United Kingdom Atomic Energy Authority). British Patent 1,249,152. 6 Oct 1971. Filed 5 Mar 1968.

Reference is made to reactors of the kind having a positive void coefficient of reactivity and wherein steam is generated from water in heat exchange with fuel housed in tubes forming part of the coolant circuit, that also includes a steam/water separator. In such reactors it is preferable to feed coolant to the tubes as near saturation temperature as possible, in order to achieve high burn-up. If steam is fed to each tube inlet individually, as in some proposals, this leads to complexity and increased cost. On the other hand, if steam is fed to a manifold serving a group of tubes, there is a risk that some of the steam will separate out and result in uncontrollable steam flow through individual tubes, thereby impairing the stability of the reactor. In the system described, the coolant circuit includes variable flow restriction means between the steam distributing means and the tubes and means for adding a variable quantity of sensible heat to sub-cooled coolant flowing between the circulating means and the distributing means. The added heat reduces the subcooling of the coolant entering the restriction means and, because of the pressure drop across the restriction means, steam may be flashed off from the coolant flowing to the tubes. The addition of heat to the coolant at a point upstream of the distributing means ensures that the heat is uniformly distributed, so that the coolant entering the distributing means is single phase. The distributing means and the variable flow restriction means are preferably embodied in a multi-outlet port valve. (UK)

3831 IMPROVEMENTS IN OR RELATING TO COOLING-GAS CIRCULATORS FOR NUCLEAR-REACTOR POWER STATIONS. Fraser, William Milton; Cairns, Walter John; MacDonald, Ian Norman (to James Howden and Co. Ltd.). British Patent 1,247,843. 29 Sep 1971. Filed 12 Oct 1967.

A problem arises in mounting a gas circulator on the wall of a concrete pressure vessel in that the concrete may be expected to contract over the life of the reactor and such contraction is likely to cause movement of the blower unit out of accurate alignment with the associated ducting. In the arrangement described a tubular housing is provided having a skirt that is free of the concrete wall, and the circulator is attached to the skirt so that the motor unit hangs in the housing and the blower unit hangs in the pressure vessel. In this way any movement of the circulator due to movement of the concrete will be minimal. Circulator attachment and clamping means are described. The ducting may include an annular portion attached to the skirt and extending axially inward from the blower outlet. (UK)

3832 HYDROGEN ACTIVITY METER FOR LMFBRs. Vissers, D. R.; Holmes, J. T.; Nelson, P. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 610-11(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3833 SODIUM SAMPLING AND ANALYSIS AT EBR-II. Olson, W. H. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: No. 2, 618-19(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3834 IMPROVEMENTS IN THORIA-YTTRIA CERAMIC ELECTROLYTES FOR OXYGEN METERS. Ross, W. A. (WADCO Corp., Richland, Wash.); Weber, E. T.; Grundy, B. R.; Berkey, E. Trans. Amer. Nucl. Soc.; 14: No. 2, 621-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3835 NITROGEN BEHAVIOR AS LMFBR REFUELING COVER GAS. Meacham, S. A.; Colburn, R. P. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 624-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3836 FAST, ACCURATE, PWR THERMAL-HYDRAULIC FEEDBACK MODEL USING PDQ7. Wittkopf, W. A.; Hassan, H. H.; Poetschat, G. R. (Babcock and Wilcox, Lynchburg, Va.). Trans. Amer. Nucl. Soc.; 14: No. 2, 658-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3837 TEMPERATURE DISTRIBUTION AND FLOW MIXING IN A 19-ROD SIMULATED LMFBR FUEL ASSEMBLY. Fontana, M. H.; MacPherson, R. E.; Gnadt, P. A.; Wantland, J. L. (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 719(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3838 7-ROD BUNDLE MIXING AND VELOCITY DISTRIBUTION EXPERIMENTS FOR LMFBR APPLICATION. Roidt, R. M. (Westinghouse Electric Corp., Pittsburgh); Markley, R. A.; Weiss, E. Trans. Amer. Nucl. Soc.; 14: No. 2, 719-21(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3839 COMPARISON OF CALCULATED AND MEASURED FLOW RATES THROUGH AN INSTRUMENTED SUBASSEMBLY IN EBR-II. Gillette, J. L.; Gopalakrishnan, A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 721-3 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3840 SIMULATION OF INTERCHANNEL COOLANT MIXING IN A SODIUM-COOLED REACTOR FUEL ASSEMBLY. Carelli, Mario D. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 728-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3841 ADVANTAGES OF PRIMARY SYSTEMS FLOW CONTROL DURING REACTOR SCRAM IN AN LMFBR. Metevia, William J.; Gilbertson, Jon C. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 753-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3842 APPROACH TO CRITICAL IN TWO-PHASE SINGLE-COMPONENT MEDIA. Mecredy, R. C.; Hamilton, L. J. (Univ. of Michigan, Ann Arbor). Trans. Amer. Nucl. Soc.; 14: No. 2, 754(Oct 1971).

From Joint meeting of the American Nuclear Society; Miama Beach, Fla. (17 Oct 1971). See CONF-711009.

3843 AUTOMATED DESIGN OF REACTOR FLUID SYSTEMS. Beard, Charles L.; Bordelon, Frank M. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc.; 14: No. 2, 754-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3844 WATER MODELING OF LIQUID-METAL DIFFUSION COLD TRAPS. Bloom, G. R.; Lester, D. H. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 755-6 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3845 PRELIMINARY RESULTS FROM HIGH-RESOLUTION GAMMA ANALYSIS OF EBR-II COVER GAS. Brunson, G. S. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: No. 2, 777-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3846 MONTE CARLO CALCULATION OF SECONDARY SODIUM ACTIVATION ON THE PHENIX REACTOR. Devillers, C.; Nimal, J. C.; Vergnaud, T. (CEN, Fontenay Aux Roses, France). Trans: Amer. Nucl. Soc.; 14: No. 2, 936-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Fuels

Refer also to abstracts 2266, 2512, and 2580.

3847 (AEEW-M-1035) THERMAL REACTOR PHYSICS MEASUREMENTS USING Pu-BEARING FUEL. Kinchin, G. H.; Johnstone, I.; Tyror, J. G. (Atomic Energy Establishment, Winfrith (England)). Jun 1971. 21p. Dep. NTIS (U. S. Sales Only).

A review is presented of the reactor physics studies which have been made in the UK on the plutonium enrichment of advanced gas-cooled reactors and more recent work relevant to plutonium recycling in SGHWRs. The range of experiments required for checking data and methods for plutonium enrichment (involving enrichments of the order of 1%) is greater than that needed for plutonium build up in uranium enriched reactors but no distinction in the objectives will be made. (35 references) (UK)

3848 (CEA-R-4237) RELIABILITY AND SAFETY OF THE FUEL ELEMENTS BELONGING TO THE GRAPHITE-GAS LINE. Ollier, Henri; Courcon, Paul; Truffert, Jacques; Blanchard, Paul; Huillery, Robert; Kandel, Joseph (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Jul 1971. 184p. (In French). Dep. NTIS (U. S. Sales Only).

The various types of fuel elements used in gas-graphite reactors were considered from two points of view: the deterioration of the canning during operation and the effect of a leak on reactor safety. The general phenomenon which affects all fuel elements is uranium oxidation by CO_2. Tubular fuel elements with a large free volume are subjected to more complex phenomena due to oxidation and instability of the can at startup or at power level. According to the operating conditions and the size of the leak, oxidation causes one instability or the other. The behaviors of graphite core fuel rods and tubular fuel rods were compared. The improvement brought about by a low porosity graphite core was demonstrated under various operating conditions. For annular fuel elements of the Bugey type, it was shown that a permanent fuel/can bond avoids any possibility of fuel melting. 12 references. (auth)

3849 (GEAP-5676) FULL-LENGTH EMERGENCY COOLING HEAT TRANSFER PROGRAM TEST PLAN. Bock, R. G. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Aug 1968. Contract AT(10-1)-205; Subcontract C-619. 41p. Dep. NTIS.

For Phillips Petroleum Co., Idaho Falls, Idaho.

The test program plan for the BWR portion of the Full-Length Emergency Cooling Heat Transfer (FLECHT) Program is presented. The project organization, estimated program costs, and a test program schedule are included. (auth)

3850 (GEAP-13197) EMERGENCY COOLING IN BOILING WATER REACTORS UNDER SIMULATED LOSS-OF-COOLANT CONDITIONS. BWR-FLECHT Final Report. Duncan, J. D.; Leonard, J. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jun 1971. Contract AT(10-1)-1230; Subcontract S-7044. 86p. Dep. NTIS.

For Idaho Nuclear Corp., Idaho Falls.

The Boiling Water Reactor Full Length Emergency Cooling Heat Transfer (BWR-FLECHT) test program has been completed. The results of the program are summarized. Five Zircaloy-clad and five stainless steel-clad full scale BWR bundle mockups were tested under simulated loss-of-coolant conditions. Approximately 150 transient and steady state tests were conducted from 1968 to 1970. The test program has significantly increased the understanding of the heat transfer performance during the emergency cooling phase of the postulated BWR loss-of-coolant accident. The test data and the analysis indicate that both the top-spray and bottom-flooding modes of emergency cooling will terminate the cladding temperature increase and minimize the consequences of the postulated loss-of-coolant accident. The models developed for spray cooling heat transfer allow a conservative prediction of the consequences of the accident. Specifically, the local cladding temperature and local cladding strength can be calculated as a function of time during the accident. (17 references) (auth)

3851 (GULF-GA-A-10784) HTGR BASE PROGRAM QUARTERLY PROGRESS REPORT FOR THE PERIOD ENDING AUGUST 31, 1971. (Gulf General Atomic Co., San Diego, Calif.). Contract AT(04-3)-167. 109p. Dep. NTIS.

The HTGR Base Program study of the base technology leading to the development of a large High-temperature Gas-Cooled Reactor (HTGR) system is reviewed. Studies of basic fission-product distribution mechanisms, recycle fuel studies (including designing and testing of recycle test elements, development of a national recycle plan and of a recycle fuel plant, and exploration of head-end reprocessing methods), and physics and fuel management studies (including design and fabrication of fuel test elements, and physics tests performed in the HTLTR) are described. Materials studies include irradiation and analysis of fuel particles in capsules to evaluate startup and recycle fuel systems, and basic studies of control materials and of carbon and graphite. Experimental procedures and results are discussed and the data are presented in tables, graphs, and photographs. (6 references) (auth)

3852 (GULF-GA-A-10803) GAS-COOLED FAST BREEDER REACTOR. Quarterly Progress Report, May 1, 1971-July 31, 1971. (Gulf General Atomic Co., San Diego, Calif.). Contract AT(04-3)-167. 44p. Dep. NTIS.

The tasks of the Gas-Cooled Fast Breeder Reactor (GCFR) program are program planning, core development, fuels and materials development, irradiation tests, and nuclear analysis and reactor physics. The status of the three volumes of the development program plan document for the GCFR demonstration plant is reported. Surveillance of materials included some recent information on cladding materials, which is summarized. The current irradiation test results and analyses are reported for capsule GB-9, which is operating in ORR and has reached 43,000 MWd/Te. Plans for the irradiation of a similar but improved capsule (GB-10) are discussed. The status of the fast-flux experiment F-1 (X094) in EBR-II and of the five F-1 replacement rods is reported. Results of out-of-pile experiments to develop cladding temperature-monitoring techniques are discussed. The background and objectives of the GCFR critical assembly program are presented. (auth)

3853 (IAE-2042) INFLUENCE OF GEOMETRICAL PARAMETERS OF THERMIONIC CONVERTERS ON THE VOLUMETRIC DENSITY OF ELECTRIC POWER IN A REACTOR GENERATOR. Kravchenko, Yu. Ya.; Stolyarov, G. A. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 24p. (In Russian). INIS.

As criteria of selection and optimization of parameters of thermionic converters, the magnitude of the volumetric density of electric power was studied in a reactor-generator. In an approximation of the isothermal emitter and linear volt-ampere characteristics, the dependence of the volumetric density of the reactor power on electrode dimensions was calculated at a constant power level. In addition, its dependence on the original power density, the thickness of the collector package, the distance between elements, and the quantity of moderator-coolant in an elemental cell was calculated. Optimal values were determined for the radius of the emitter, collector, and electrode length at specified parameters of those remaining. For example, for an initial specific power of 10 W/cm^2 the volumetric power density was 6 W/cm^3. (tr-auth) (INIS)

3854 (LA-DC-12808) STATUS OF BURNUP MEASUREMENT METHODOLOGY. Rein, J. E. (Los Alamos Scientific Lab., N. Mex.). [1971]. 32p. (SM-149/40; CONF-711107-7). Dep. NTIS.

From Symposium on analytical methods in the nuclear fuel cycle; Vienna, Austria (29 Nov 1971).

The various chemical methods in use to measure burnup of nuclear fuels irradiated in thermal and fast reactors are reviewed. Methods based on fission product measurements are shown to be most accurate, especially for fast reactor fuels. Selection criteria are given for fission product burnup monitors. Based on these criteria, selected monitors are recommended for various nuclear fuels. The status of nuclear data important to burnup calculations is reviewed. The variables include fission yields for various fissioning nuclides and neutron capture cross sections for fission products. Experiments in progress in the USAEC Fast Breeder Program to obtain fast reactor nuclear data are described. Analytical chemistry methods used for the determination of fission product monitors, uranium, and plutonium are reviewed on the bases of measurement accuracy, complexity of analysis, and equipment cost. The techniques in-

clude isotope dilution mass spectrometry, x-ray spectrometry, optical spectrophotometry, spark source mass spectrometry, and gamma-ray scanning of whole fuel pins. (14 references) (auth)

3855 (RISO–243) ON FUEL ASSEMBLIES WITH DEFLECTORS FOR STEAM–WATER SEPARATION FOR BOILING-WATER REACTORS. Marstrand, Joergen (Danish Atomic Energy Commission, Risoe. Research Establishment). Jul 1971. 76p. Dep. NTIS (U. S. Sales Only).

A new fuel assembly concept is presented which postulated higher burnout limits than those obtained with the previous technique. This is obtained from deliberate control of the coolant flow in boiling-water reactor fuel assemblies, which yields in addition a considerable steam–water separation. An investigation of droplet motion depending on their size was carried through on a theoretical basis. This shows that a very considerable sorting by size of the droplets takes place. Application of the new fuel concept should provide economic advantages as well as advantages from a safety point of view. 12 references. (auth) (Denmark)

3856 BEHAVIOR OF FUEL RODS AT HIGHER DEGREES OF BURNUP. Krummerer, K. (Kernforschungszentrum, Karlsruhe, Ger.); Stehle, H.; Weidinger, H. G. Atomwirt., Atomtech.; 16: No. 10, 545-52(Oct 1971). (In German).

Surveyed are factors associated with higher degrees of burnup such as problems of construction elements, changes in material, and breakdown events. The topics are treated with respect to fuel rods for boiling water reactors and fast reactors. Because of the fact that sufficient experience about higher degrees of burnup is available only for oxide fuels, the survey considers only oxides. Physical and chemical changes within fuel and cladding are discussed. Special problems of fuel rods are delineated from design to actual installation. (tr-auth)

3857 RADIATION PROPERTIES OF SPENT PLUTONIUM FUELS. Bell, M. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 484(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3858 WESTINGHOUSE NUCLEAR FUEL EXPERIENCE. Kramer, F. W.; Roll, J. B. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc.; 14: No. 2, 563(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3859 THERMAL REACTOR MIXED-OXIDE FUEL PERFORMANCE. Freshley, M. D. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 563-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3860 ANALYTICAL MODEL DESCRIBING THE RELEASE OF FISSION PRODUCTS FROM OPERATING FUEL PINS. Yuill, W. A.; McFadden, J. H.; Baston, V. F. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc.; 14: No. 2, 770-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3861 SEISMIC CONSIDERATIONS IN THE GCFR CORE. Buttemer, David R. (Gulf General Atomic, San Diego, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 783-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3862 PROBLEMS IN RECYCLE OF PLUTONIUM IN PRESSURIZED WATER REACTORS. Hellens, Robert L. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 820(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3863 BWR PLUTONIUM RECYCLE PHYSICS. Crowther, R. L.; Fischer, D. L. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 820-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3864 EFFECTS OF PLUTONIUM CHARACTERISTICS ON RELOAD FUEL DESIGN FOR LWRs. Tomonto, James R.; Hamilton, George T. Trans. Amer. Nucl. Soc.; 14: No. 2, 821-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3865 STATUS OF REACTOR PHYSICS TECHNOLOGY RELATED TO Pu-RECYCLE FUEL LICENSING. Schmid, L. C.; Carter, N. E.; Jenquin, U. P.; Leonard, B. R. Jr.; Wolkenhauer, W. C. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 822-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3866 SPACE-ENERGY-DEPENDENT PHYSICS PROBLEMS OF PLUTONIUM FUELS IN HTGRs. Asmussen, K. W.; Waelti, P. (Gulf General Atomic, San Diego, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 823-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3867 REVIEW OF THE ITALIAN ACTIVITIES FOR THE THERMAL RECYCLING OF PLUTONIUM. Schileo, G. (CNEN, Rome). Trans. Amer. Nucl. Soc.; 14: No. 2, 824(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3868 SIGNIFICANT ITEMS ON THE FEATURES OF PLUTONIUM RECYCLE FROM PHYSICAL AND TECHNOLOGICAL STANDPOINTS. Orestano, F. V.; Pistella, F.; Testa, G. (CNEN, Rome). Trans. Amer. Nucl. Soc.; 14: No. 2, 824-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Auxiliary and Emergency Systems

Refer also to abstract 3900.

3869 (AECL–4054) MONITORING REACTOR EFFLUENTS FOR TRITIUM: PROBLEMS AND POSSIBILITIES. Osborne, R. V. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sep 1971. 34p. (CONF-710809–8). Dep. NTIS (U. S. Sales Only). AECL $1.00.

From Tritium symposium; Las Vegas, Nev. (30 Aug 1971).

Adequate sensitivity, appropriate response time and the ability to operate continuously under industrial conditions are general requirements for all power reactor monitoring systems for tritium. Insensitivity to gamma radiation, fission products, activation products, humidity, dirt and luminescent materials is also needed. For monitoring water effluents, a plastic scintillator detector is capable of measuring down to 1 nCi cm^{-3} tritium in water, with a response time less than one minute. A liquid scintillation flow cell system with a comparable response time gives more sensitivity, and interference from contaminants is more easily overcome. For slower response times, scintillator is used at a lower rate so running costs are lower. For air effluents, ionization methods have the advantage of simplicity. Concentrations down to 1 pCi cm^{-3} can be measured easily but if varying proportions of noble gases are present in sampled air, interference is difficult to avoid. The plastic scintillation detector can detect less than 1 pCi cm^{-3} and contaminants are more easily discriminated against. Condensation, exchange with water or collection in liquid scintillator enable activities to less than 0.1 pCi cm^{-3} in air to be monitored continuously with very good discrimination against contaminants. Response times may be from several minutes to several hours. Choice between the various monitoring systems for tritium in water and tritium in air therefore depends upon the combination of sensitivity and response time needed, likely contaminants and running costs. 23 references. (auth)

3870 (ORNL–4671) REMOVAL OF RADIOACTIVE PARTICLES BY SPRAYS. Parsly, L. F. (Oak Ridge National Lab., Tenn.). Nov 1971. Contract W-7405-eng-26. 50p. Dep. NTIS.

The theory of particle removal by sprays is reviewed, and the results of a number of recent experiments by others and 15 experiments in the ORNL Nuclear Safety Pilot Plant are discussed. The experimental results show that particle removal is not significant when no steam is condensing on the spray drops but is greatly enhanced when condensation occurs. A major part of the removal by condensation is due to drop nucleation on the particles and the combined effects of diffusiophoresis and Stephan flow. Drop nucleation is a transient phenomenon and appears unpredictable, but the rate of removal due to the other phenomena can be predicted within a factor of 2 or better. (43 references) (auth)

3871 DEVICE FOR HANDLING CONTROL RODS. Radiguet, Pierre (to Societe pour l'Industrie Atomique SA). French Patent 2,045,599. 5 Mar 1971. Filed 5 Jun 1969. (In French).

Equipment for handling the control rods of a high temperature gas cooled reactor is described. The equipment enables the rods and their associated components to be handled and lifted up. It consists of a hollow head traversed by a sliding extending axial stem, and a guide tube coaxial to the control rod. An assembly of three individually actuated grapnels enables the stem, guide tube, and rod head to be grasped. (France)

3872 DEVICE FOR HANDLING CONTROL RODS. Margueron, Jean (to Societe Pour l'Industrie Atomique SA). French Patent 2,045,598. 5 Mar 1971. Filed 5 Jun 1969. (In French).

Equipment for handling the control rods of a high temperature gas cooled reactor is presented. The equipment enables the rods and their associated components to be handled and lifted up. The control rod which is vertical is provided with a head capable of being grasped by a grapnel. The equipment consists of a guide tube coaxial to the control rod and a remote-control locking device mounted between the guide tube and the rod head. (France)

3873 MOLTEN CORE STOPPING DEVICE. West, John M.; Fletcher III, William D. (to Combustion Engineering, Inc.). U. S. Patent 3,607,630. 21 Sep 1971. Filed 22 Aug 1969.

A water-cooled metal basin is located under a nuclear reactor vessel to catch, cool, solidify and retain molten core material dropped from the vessel upon a burn-through of the vessel. A plurality of horizontally disposed water-filled tubes in the basin have a common inlet connected with an elevated storage tank and have discharge outlets positioned at a height at least equal to the water level in the storage tank. The basin provides a level floor on which the molten core material may spread out in a thin layer and be solidified and maintained solid by transfer of heat to water passing through the tubes. The tubes may also extend vertically above the basin to absorb heat radiated from the upper surface of the layer and radiating fins may be provided in the basin. A second material may also be provided to absorb heat from the molten reactor material by melting of the second material thereby solidifying the molten core material. Waterflow is started automatically by convection and gravity. (auth)

3874 INSTALLATION FOR CLADDING SURVEILLANCE OF FUEL ELEMENTS IN POWER REACTORS. Jacobi, S.; Tradowsky, K. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 16: No. 10, 537-9(Oct 1971). (In German).

The mode of operation is described for installations monitoring cladding defects of fuel elements in light water reactors and in sodium-cooled reactors. In water-cooled reactors, xenon and krypton are separated from the cooling medium and precipitated. Experimental studies show that cladding defects of 0.1 mm^2 can be detected. In sodium-cooled reactors, monitoring is based on the measurement of delayed neutron emission by fission products. Design of the neutron monitor is described. 12 references. (H.B.G.)

3875 ICE CONDENSER REACTOR SYSTEM CONTAINMENT. Iredale, A. J. F.; Grimm, N. P. Nucl. Eng. Int.; 16: No. 185, 864-8(Oct 1971).

Sequoyah was the second nuclear station to adopt the ice condenser system and the first to combine it with a free-standing, steel containment vessel. The ice condenser configuration is described and system performance under postulated-accident conditions is discussed. (auth) (UK)

3876 STARTUP NEUTRON DETECTORS FOR LMFBR APPLICATION. Roux, D. P. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 497(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3877 DESIGN AND PERFORMANCE OF HYDROGEN METER FOR DETECTING WATER-TO-SODIUM LEAKS IN LMFBR STEAM GENERATORS. McPheeters, C. C.; Vissers, D. R.; Slawecki, M. A.; Nelson, P. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 614(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3878 DEVELOPMENT AND SODIUM TESTING OF AN ELECTROCHEMICAL HYDROGEN METER. Arbiter, W.; Fuhrman, N.; Holden, R. B. (Gulf Nuclear Fuels Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 620-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3879 TRANSIENT ANALYSIS OF THE ICE CONDENSER REACTOR CONTAINMENT. Bordelon, F. M.; Colenbrander, H. G. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc.; 14: No. 2, 766-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3880 DESIGN OF INSTRUMENTATION CABLES FOR LMFBR APPLICATION. Schemmel, R. R.; Stringer, J. L.; Philipp, L. D. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 784(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Operation and Economics

3881 (AEEW-M-1030) INTRODUCTORY NOTES ON THE GENERAL PRINCIPLES OF FUEL MANAGEMENT. Fayers, F. J. (Atomic Energy Establishment, Winfrith (England)). Apr 1970. 27p. Dep. NTIS (U. S. Sales Only).

The decisions made about the timing of fuel loading operations, the choice of enrichments to be loaded, the selection of sites at which loading occurs, and the programming of control rods and other reactivity control facilities such as soluble or burnable poisons, collectively constitute what is referred to as fuel management. The choice of fuel management strategy is the key factor determining the history of axial and radial form factors, as well as cluster peaking factors within the bundle, and these determine the consequent burnup of the reactor. Strategies based on all these factors are considered and methods of calculation are given. (10 references) (UK)

3882 (EUR-4505) ORGEL PROJECT: 1959-1969. Leny, J. C.; Orlowski, S. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1971. 106p. (In French). Dep. NTIS (U. S. Sales Only). FF 16,60.

The conditions under which a heavy water reactor was selected for the Community programme are reviewed. The reasons for choosing the ORGEL variant, cooled with organic liquid are described. After sketching in the context in which ORGEL was launched, the aims and achievements are discussed. The Community climate and the general nuclear situation which led the Commission to stop the project as soon as the objectives set for ORGEL by the two first Five-Year Programmes were reached are described. An annex containing a summary of the main technical principles adopted as guidelines for the research programme is presented. 25 references. (auth)

3883 DAMAGE IN NUCLEAR POWER PLANTS. Feldmann, J. Maschinenschaden; 43: No. 5, 165-71(1970). (In German).

Following a brief review of damage experience during the construction of nuclear power plants in Germany, various aspects of damage during the operation of nuclear power plants are examined. A critical review of individual incidents and repairs is presented. This clearly shows that repairs can be successfully carried out on highly activated plant sections within the pressure vessel. (UKAEA Info. Bulletin)

3884 NUCLEAR POWER: A NEW SOURCE OF ENERGY FOR AUSTRIA. Oszuscky, F. J. P. J. Inst. Nucl. Eng.; 12: No. 5, 140-1(Sep-Oct 1971).

The energy requirements of Austria are briefly reviewed. While these are met mainly by hydroelectric schemes, supplementary sources are receiving consideration. Eight Austrian utilities decided in 1970 to establish a nuclear power company known as the Gemeinschafts Kernkraftwerk Tullnerfeld, with the goal of erecting and operating the first Austrian nuclear power station of about 700 MW(e) unit size. Economics are discussed. Tenders were for light water reactor types, and a decision has been taken to build a 700 MW(e) BWR; full operation is expected around 1976. The total generating costs are expected to be competitive with hydroelectric plants. (UK)

3885 COMMERCIAL PLUTONIUM RECYCLE. Roll, J. B. J. Inst. Nucl. Eng.; 12: No. 5, 134-6(Sep-Oct 1971).

The technology and economics of Pu in relation to reactor operation are first discussed, followed by a description of the Pu recycle program sponsored by the USAEC. (UK)

3886 STATUS REPORT OF EEI PLUTONIUM RECYCLE PROJECT (BWR). Walke, Gerald J. (Consumers Power Co., Jackson, Mich.). Trans. Amer. Nucl. Soc.; 14: No. 2, 471(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3887 STATUS REPORT OF EEI PLUTONIUM RECYCLE PROJECT (HTGR) Walker, Richard F. (Public Service Co. of Colorado, Denver). Trans. Amer. Nucl. Soc.; 14: No. 2, 471-2 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3888 PLUTONIUM FUEL PENALTY. Vanden Bemden, E. (Belgonucleaire, Brussels). Trans. Amer. Nucl. Soc.; 14: No. 2, 472(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3889 EFFECTS OF BATCH FRACTION, PLUTONIUM ENRICHMENT, AND PLUTONIUM VALUE ON THE ECONOMICS OF PLUTONIUM RECYCLE. Woods, J. J. (Babcock and Wilcox, Lynchburg, Va.). Trans. Amer. Nucl. Soc.; 14: No. 2, 473-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3890 OPERATIONAL PLANNING MODEL FOR MULTI-NUCLEAR UNIT SYSTEMS. Rhodes, J. T.; Fulford, P. J. (Purdue, Univ., Lafayette, Ind.). Trans. Amer. Nucl. Soc.; 14: No. 2, 492-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3891 EFFECTS OF OPTIMAL BLANKET SHAPE ON THE LMFBR FUEL CYCLE. Spitzer, Josef E.; O'Dell, R. Douglas (Univ. of New Mexico, Albuquerque). Trans. Amer. Nucl. Soc.; 14: No. 2, 493-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3892 OPTIMIZATION OF A HELIUM-STEAM BINARY CYCLE. McCracken, Kenneth W.; Rust, James H. (Georgia Inst. of Tech., Atlanta). Trans. Amer. Nucl. Soc.; 14: No. 2, 712-13(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3893 LOAD-FOLLOWING CAPABILITY OF CANDU REACTORS. Akhtar, P.; Trojan, O. A. (Atomic Energy of Canada Ltd., Sheridan Park, Ont.). Trans. Amer. Nucl. Soc.; 14: No. 2, 753(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3894 FUEL CYCLE FLEXIBILITY. Schmidt, R. A. Nucl. Eng. Int.; 16: No. 185, 870-2(Oct 1971).

The boiling water reactor has many characteristics which result in operating flexibility. The moderate power density characteristics permit the refueling interval to be optimized to meet individual utility requirements. Intervals as long as 18 months may be employed to reduce the number of outages and reduce total power system costs by amounts as high as $4M/reactor. The characteristic of steam voids in the core may be used to gain additional flexibility in changing the date of a refueling outage. The feedwater temperature reduction method of extended operation holds the plant electrical output to nearly the rated capacity and also reduces total costs by amounts as high as $2 to 4M/reactor. (auth) (UK)

Safety and Siting

3895 (ANL-Trans-903) COMPILATION OF MOST RECENT EXPERIMENTAL RESULTS ON FUEL PIN FAILURE AND FUEL-SODIUM INTERACTION. Kessler, G. (Kernforschungszentrum, Karlsruhe (West Germany)). Translated for Argonne National Lab., Ill., from report PSB-389/1971. 48p. Dep. NTIS.

The results of the TREAT experiment with series S, E and H published up to March 1971 have been compiled and compared with the melt down experiment of Atomics International. A critical analysis shows that the mechanical energy conversion factor is ≤0.2% in all experiments. A comparison of the particle size distributions occurring during the fuel-sodium interaction shows that the mean particle size falls in the range of 0.2 to 0.5 mm in all experiments. Similar results were also obtained in the Spert experiments. The significance of these results for an estimate of the effects of severe hypothetical accidents in fast sodium-cooled reactors is discussed. (20 references) (auth)

3896 (BAW-10034) MULTINODE ANALYSIS OF B AND W's 2568-MWt NUCLEAR PLANTS DURING A LOSS-OF-COOLANT ACCIDENT. Parks, C. E.; Dunn, B. M.; Schermer, W. J. (Babcock and Wilcox Co., Lynchburg, Va. Nuclear Power Generation Dept.). Oct 1971. 164p.

Multinode analyses were conducted to evaluate several loss-of-coolant accidents for 2568-MW(t) pressurized-water reactors. Time step and noding studies are presented, basic assumptions are listed, and the selection of base parameters is discussed. The multinode model was used to perform a core cooling analysis for a spectrum of break sizes. Curves showing the parameters of interest are presented. (13 references) (auth)

3897 (BMI-1916) ECCSA AND MUCHA: COMPUTER CODES FOR THE ANALYSIS OF EMERGENCY-CORE-COOLING SYSTEMS. Topical Report, Task 18. Cudnik, Ronald A. (Battelle Columbus Labs., Ohio). Sep 1971. Contract W-7405-eng-92. 183p. Dep. NTIS.

Several computer codes have been developed for the analysis of a reactor loss-of-coolant accident and subsequent emergency-core-cooling injection. Included are the ECCSA4 code, which was developed to predict the thermal and hydraulic behavior of a single reactor fuel rod and its associated core channel; the MUCHA2 and MUCHA1 codes, which are pressure-coupled, parallel core channel codes initially developed to investigate the possibility of preferential flow due to thermally dissimilar channels; and the expanded version of the MUCHA2 code, which was developed to provide the capability of analyzing the complete primary system with the core heat-transfer effects intimately coupled to the system analysis. The mathematical models which have been developed to describe the thermal and hydraulic processes are discussed in detail. These include models for heat conduction, heat generation, metal-water reaction, core fluid behavior, and plenum behavior. Source decks and sample problems for ECCSA4, MUCHA2, and MUCHA1 will be available through the Argonne Code Center for the CDC-6400 computer. 32 references. (auth)

3898 (ISS-71/16) SITING CRITERIA FOR NUCLEAR PLANTS. Amaldi, U. Jr.; Venuti, C. Campos; Frullani, S.; Maiani, L.; Tabet, E. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). 18 Jul 1971. 37p. (In Italian). Dep. NTIS (U. S. Sales Only).

The licensing procedures for nuclear reactor sites adopted in Italy and in various foreign countries are described. The relative importance given in each different country to the various aspects which determine the quality of a particular site, such as physical, geological, ecological and sociological characteristics is brought into focus. The importance of long-range programming for nuclear as well as for fossil fueled power plants, both at a national and a regional level, is pointed out. Possible extensions of nuclear methods for site analysis to conventional plants are discussed. 23 references. (auth)

3899 (LIB/Trans-344) REACTOR SAFETY. Groos, Otto H. Translated by J. Hopkinson (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from pp 338-46 of Taschenbuch fur Atomfragen, 1968. 10p. Dep. NTIS (U. S. Sales Only).

An assessment is made of the responsibilities entailed in reactor safety operations. The analysis covers organizations and personnel, designing and fabricating components, operating staff and associated personnel, and those responsible for approving operation control and inspection of nuclear power stations (including legally established authorities). (Australia)

3900 (ORNL-TM-3554) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT FOR JULY-AUGUST 1971. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 132p. Dep. NTIS.

The accomplishments during the months of July and August in the research and development program on nuclear safety are summarized. Much of this work is in general support of water-cooled power reactor technology, including LOFT and industry programs, and reflects current safety problems, such as blowdown heat transfer studies. Several projects are also conducted in support of the high-temperature gas-cooled reactor (HTGR) and the liquid-metal fast breeder reactor (LMFBR) programs. Other major projects are those on primary piping and steel pressure-vessel technology. They also include experimental investigations of the attachment of nozzles to shells and the implementation of joint AEC-PVRC programs on heavy-section steel technology and nuclear piping, pumps, and valves. Seismic considerations of particular significance in nuclear plant design are evaluated in the seismic program. Several of the above projects are also directly related to the AEC's standards program, which entails development of engineering safeguards and the establishment of codes and standards for government-owned or -sponsored reactor facilities. The recent activities of NSIC and the Nuclear Safety journal in behalf of the nuclear community are also discussed. Of particular interest in both of these activities is the recent emphasis on environmental effects. (auth)

3901 SOME PROBLEMS OF STUDYING EMERGENCIES IN A NUCLEAR POWER PLANT WITH PRESSURIZED WATER REACTOR. Kuznetsov, V. D. (Technical Univ., Dresden). Kernenergie; 14: No. 6, 188-90(Jun 1971). (In Russian).

Some problems of analyzing the loss of coolant in a nuclear power plant with pressurized water reactor are described. Inaccuracies caused by an excessive simplification of the models of the analysis of the loss of coolant are analyzed. 5 references. (auth)

3902 INSTRUCTIONS TO THE DELEGATION FOR ATOMIC ENERGY SAFETY QUESTIONS. Sv. Forfattningssamling; No. 490(Jun 1971). (In Swedish).

Supersedes Instruction 1961:490.

The composition and function of the delegation for atomic energy safety questions are defined. The organization and modus vivendi of the delegation and the cooperating Reactor Siting Committee are described. (Sweden)

3903 WESTINGHOUSE OFFSHORE NUCLEAR POWER TECHNOLOGY. Nichols, R. C.; Haga, P. B. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc.; 14: No. 2, 453-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3904 CORRELATION OF EXPERIMENTAL BLOWDOWN AND REFLOODING DATA USING THE CRAFT CODE. Jensen, W. L. (Babcock and Wilcox, Lynchburg, Va.). Trans. Amer. Nucl. Soc.; 14: No. 2, 698(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3905 LOSS-OF-COOLANT METHODS DEVELOPMENT. Bingham, B. E.; Roberson, C. E. (Babcock and Wilcox, Lynchburg, Va.). Trans. Amer. Nucl. Soc.; 14: No. 2, 698-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3906 FLASH-3 ANALYSIS OF THE LOFT SEMISCALE TEST 845. Murphy, J. H.; Redfield, J. A. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 704(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3907 NUMERICAL GUIDANCE FOR RADIOACTIVE EMISSIONS FROM LIGHT-WATER-COOLED NUCLEAR POWER REACTORS. Gamertsfelder, Carl (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 705 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3908 ANS BWR CRITERIA: COMPATIBILITY WITH INDUSTRY CODES. Gilbert, W. D. (Atomic Power Development Associates, Inc., Detroit); D'Ardenne, W. H. Trans. Amer. Nucl. Soc.; 14: No. 2, 705-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3909 SAFETY GUIDES FOR WATER-COOLED NUCLEAR POWER PLANTS. Smith, Ray G. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 706-7 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3910 IEEE EQUIPMENT QUALIFICATION GUIDES. Steigelmann, W. H.; Carfagno, S. P.; Kierstead, R. E. Trans. Amer. Nucl. Soc.; 14: No. 2, 707(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3911 COOLANT EXPULSION AND REENTRY FOLLOWING RAPID FISSION GAS RELEASE IN LMFBR SUBASSEMBLIES. Chawla, T. C.; van Erp, J. B.; Fiala, C.; Fauske, H. K. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 730(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3912 ANALYSIS OF PIN FAILURE IN A CLOSELY PACKED SEVEN-PIN CLUSTER AUTOCLAVE EXPERIMENT IN THE TREAT REACTOR. Agrawal, A. K. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 731-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3913 EFFECTS OF FUEL-COOLANT INTERACTIONS ON KINETICS DURING DISASSEMBLY OF AN LMFBR. Rowe, Steven; Mills, Joseph C.; Kastenberg, William E. (Univ. of California, Los Angeles). Trans. Amer. Nucl. Soc.; 14: No. 2, 734-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3914 FUEL-COOLANT INTERACTIONS IN LMFBR CONTAINMENT ANALYSES. Marciniak, T. J. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 735(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3915 ALTERNATE PRINCIPLE LMFBR SHUTDOWN SYSTEMS. Noyes, R. C.; Gilberston, J. C. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 735-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3916 PARTIAL VOIDING AND FISSION PRODUCT GAS IN LMFBR DISASSEMBLY CALCULATIONS. Nicholson, R. B.; Jackson, J. F. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: No. 2, 737(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3917 TWO-DIMENSIONAL SPATIAL EFFECTS IN FAST REACTORS DURING SODIUM VOIDING. Bezella, W. A. (Argonne National Lab., Ill.); Ott, K. O. Trans. Amer. Nucl. Soc.; 14: No. 2, 737-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3918 CONDENSATION OF A LARGE SODIUM VAPOR BUBBLE AFTER A FAST REACTOR DISASSEMBLY ACCIDENT. Reynolds, A. B. (Univ. of Virginia, Charlottesville); Kennedy, M. F.; Honig, H. Trans. Amer. Nucl. Soc.; 14: No. 2, 738-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3919 SOME SAFETY ASPECTS OF FILM CONDENSATION DURING FUEL-FAILURE ACCIDENTS. Cronenberg, August W.; Fauske, Hans K. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 739-40(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3920 CONDUCTIVE HEAT TRANSFER MODEL FOR POST-BURST ACCIDENT ANALYSES. Marciniak, T. J.; Chang, Y. W. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 740-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3921 SUB-PROMPT CRITICAL TRANSIENTS IN SEFOR. Noble, L. D. (General Electric Co., Sunnyvale, Calif.); Kussmaul, G.; Pflasterer, G. R. Trans. Amer. Nucl. Soc.; 14: No. 2, 741(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3922 PREDICTION AND MEASUREMENT OF REACTIVITY EFFECTS DUE TO THERMAL BOWING OF EBR-II SUBASSEMBLIES. Mohr, D.; Gopalakrishnan, A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 741-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3923 LIQUID FILM THICKNESSES AND MECHANISM FOR DRYOUT DURING LMFBR LOSS-OF-FLOW ACCIDENTS. Grolmes, M. A.; Fauske, H. K. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 743-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3924 COOLANT TRANSIENT SIMULATION IN LOOP CONCEPTS FOR THE FEFP PROGRAM. Thompson, D. H. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 744-5 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3925 EBR-II SYSTEM KINETICS DURING OFF-NORMAL PRIMARY FLOW CONDITIONS. Campise, A. V. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: No. 2, 745(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3926 FUEL DYNAMICS TREAT SIMULATION TESTS ON LMFBR LOSS OF FLOW. Carter, J. C.; Dickerman, C. E.; Burns, T.; Stephenson, M. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 745-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3927 EXPERIMENTAL STUDY OF COOLANT CROSSFLOW AND SUBCHANNEL FLOW BLOCKAGE IN A SIMULATED LMFBR SUBASSEMBLY. van Erp, J. B.; Chawla, T. C. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 746-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3928 LOCAL FLOW BLOCKAGE EFFECTS ON LMFBR CLADDING. Zoubek, John; Graham, John (Westinghouse Elec-

tric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 747-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3929 HYDRODYNAMIC CHARACTERISTICS OF A WAKE BEHIND A FUEL ASSEMBLY LOCAL FLOW BLOCKAGE. Bishop, A. A.; Graham, John; Zoubek, J. A. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 748-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3930 PROBABILISTIC ASSESSMENT OF AIRCRAFT HAZARD FOR NUCLEAR POWER PLANTS. III. Wais, E. A. (Holmes and Narver, Inc., Los Angeles); Kennedy, R. P.; Wall, Ian B. Trans. Amer. Nucl. Soc.; 14: No. 2, 767-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3931 SELECTION OF FUNCTIONAL TEST INTERVALS FOR EMERGENCY SAFETY SYSTEMS USING BAYESIAN DECISION THEORY. Buoni, F. B.; Redmond, R. F. (Ohio State Univ., Columbus). Trans. Amer. Nucl. Soc.; 14: No. 2, 768-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3932 TIME-DEPENDENT, MULTI-VOLUME FISSION PRODUCT TRANSPORT AND REMOVAL ANALYSIS. Pasedag, W. F.; Somers, E. V. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc.; 14: No. 2, 770(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3933 CRITICAL REMARKS TO SAFETY ANALYSIS BY MEANS OF THE DESIGN BASIS ACCIDENT. Watzel, G. V. P. Atomwirt., Atomtech.; 16: No. 10, 533-4(Oct 1971). (In German).

The differentiation between credible and incredible accidents is unsatisfactory because too many subjective factors are involved and because interference of various safety installations with each other is not taken into account. By means of the probability method, the design basis accident can be developed into an objective, quantitative, and logical process. As a consequence, it should be applied to the safety analysis of nuclear power stations even though the necessary input data of desirable precision are not available as yet. (H.B.G.)

3934 NEW APPROACH TO THE CONSTRUCTION AND SITING OF NUCLEAR POWER STATIONS. Dawes, F. A.; Mathias, D. J. J. Inst. Nucl. Eng.; 12: No. 5, 129-31(Sep-Oct 1971).

A scheme is outlined whereby nuclear power units would be constructed in a port facility in the form of a hull of steel or concrete and towed to selected and prepared off-shore sites, where they would be ballasted and partially submerged. The hull would contain all the essential components of a nuclear power station, and the units would be towed to their operating positions in an unfueled condition. It is envisaged that day-to-day servicing and personnel access would be via a jetty. Power export would be by overhead or submerged lines. Apparent advantages and disadvantages are itemized. In order to avoid the production of large amounts of ^{24}Na and other isotopes arising from seawater, a neutron shield should be inserted around the reactor vessel. The proposal is for a unit comprising a single reactor and turbo-alternator set, but a full-scale economic study might suggest alternatives. (UK)

Power Conversion Systems

3935 (BMBW-FBK-71-4) DEVELOPMENT PROGRAM: STEAM COOLED FAST REACTOR. FINAL REPORT, PART 2. DEVELOPMENT OF COMPONENTS. Agemar, F.; Andres, H.; Buechner, G.; (and others) (Allgemeine Elektricitaets-Gesellschaft, AEG-Telefunken, Grosswelzheim (West Germany). Maschinenfabrik Augsburg-Nuernberg A. G., Nuremberg (West Germany)). Jun 1971. 292p. (In German). Dep. NTIS (U. S. Sales Only).

Two evaporator concepts, steam-compressor/turbine, fast opening valves for control rod drives, special direct electrically heated tubes and insulated test channels for fuel element research, and new test facilities are described for the 300 MW(e) steam cooled fast breeder prototype reactor. 20 references. (auth)

3936 TECHNIQUES FOR MEASURING WETNESS OF STEAM. Ruetz, J. (VEB Kernkraftwerke, Greifswald, Ger. Lehr- und Versuchskraftwerk, Rheinsberg, Ger.). Kernenergie; 14: No. 6, 182-7(Jun 1971). (In German).

Measurement of wetness of live steam in nuclear power plants producing dry steam is discussed. The well-known techniques of measuring wetness of steam are reviewed. A technique suitable for continuous high-accuracy measurement during operation is proposed. An example for direct measurement is described. 14 references. (auth)

3937 GAS TURBINE POWER PLANT INCLUDING A NUCLEAR REACTOR AS HEAT SOURCE. Strub, R. (to Sulzer Brothers Ltd.). Canadian Patent 874,731. 6 Jul 1971. Priority date 27 Jul 1967, Switzerland.

In a closed cycle CO_2-gas turbine power plant, part of the CO_2 flow downstream of an intermediate level compressor is condensed prior to pumping to higher pressure. The heat is applied by a nuclear reactor in a heating step between successive expansions in which, for control of pressure in the reactor, a line is provided. There are also adjustable flow means responsive to reactor inlet pressure, connecting the outlet of the condenser with the inlet of the reactor. (F.S.A.) (Canada)

3938 TRANSIENT SEISMIC ANALYSIS OF HTGR NUCLEAR POWER PLANTS. Jeng, C. C. (Gulf Energy and Environmental Systems, San Diego, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 782-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3939 NUCLEAR POWER PLANTS. George, Brian Victor; White, Vernon Cranfield (to British Nuclear Design and Construction Ltd.). British Patent 1,248,207. 29 Sep 1971. Filed 30 Nov 1967.

Reference is made to nuclear power plants that include a gas cooled reactor and a reheat steam turbine. In conventional designs boilers located within the pressure vessel produce steam for the turbine and reheaters are provided within the pressure vessel. The provision of a reheater within the pressure vessel is expensive and introduces complications concerned with the need for associated pipework to pass through the pressure vessel wall. Such pipework is also expensive, and gives rise to undesirable heat losses owing to its length, in addition to other disadvantages. In the system described the reheater is outside the pressure vessel, so that substantially the only pipework of the main steam circuit passing through the pressure vessel wall is that for supplying feedwater to the boilers and removing steam therefrom. The reheater is preferably mounted on the turbine foundations. The turbine may include a dual flow intermediate-pressure cylinder, wherein the reheater is in two parts straddling this cylinder, each part of the reheater being connected to a cylinder outlet. The arrangement also allows for use of plain tube boilers, which may also be of larger type for a given space in the pressure vessel. (UK)

Research and Test Reactors

Refer also to abstracts 2114, 2130, 2583, 2598, 3754, 3789, 3796, and 4051.

3940 (ANL-Trans-902) ANALYSIS OF THE CENTRAL REACTIVITY COEFFICIENTS IN THE RAPID ASSEMBLY DEVICE. Voropaev, A. I.; Dulin, V. A.; Kazanskii, Yu. A.; Mamontov, V. F.; Sidorov, G. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). Translated for Argonne National Lab., Ill., from report FEI-247. 19p. Dep. NTIS.

The results of measuring the reactivity coefficients U-235, Pu-239, gold, tantalum, boron-10 and the activation of gold and copper dependent on sample dimensions in the center of the BFS-22 fast assembly device are given. A comparison between calculated and experimental results is presented. The calculations for the dependence of the reactivity and activation coefficients on the sample dimensions were made taking into consideration a "weakening" of the flow in the sample with the Wigner approximation using blocking coefficients of the BNAB constant system. An analysis of the differences between some of the calculated and experimental results is given. 7 references. (auth)

3941 (APDA-269) COMPARISON AND ANALYSIS OF METHODS FOR DETERMINING HETEROGENEITY EFFECTS IN FAST CRITICAL ASSEMBLIES AND REACTORS. Page, E. M.; Mueller, R. E.; Komata, M.; Mahna, K. L. (Atomic Power Development Associates, Inc., Detroit, Mich.). Jun 1971. Contract AT(11-1)-865. 172p. Dep. NTIS.

Work performed under United States–Euratom Fast Reactor Exchange Program.

Methods for determining heterogeneity effects in fast reactor plate-type critical assemblies and power reactors, particularly

with regard to system criticality and central sodium voiding, are compared. Several methods are used to determine the flux distribution heterogeneity effect, most of which incorporate spatial weighting techniques to obtain weighted cross sections that account for the heterogeneity of the system. The computer codes DTF-IV, CALHET, and MDF-IV/BICAL (a modification of DTF-IV to accommodate bilinear weighting) were utilized in the cross section averaging processes. The methods were intercompared, as well as compared with pertinent heterogeneity experiments performed in selected critical assemblies. ZPR-III Assemblies 48 and 51, ZPR-VI Assembly 6, and a demonstration reactor design were included in the analysis. Considerable attention was afforded the energy-dependent mechanisms of the heterogeneity effect as revealed by the multigroup approach incorporated in the various methods. 57 references. (auth)

3942 (CEA-R-4246) NEUTRONIC STUDY OF FAST-NEUTRON MULTIPLYING MEDIA ON A FAST THERMAL CRITICAL ASSEMBLY: ERMINE II. Bouchard, Jacques; Menessier, Pierre; Vidal, Rene (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Sep 1971. 139p. (In French). Dep. NTIS (U. S. Sales Only).

The fast thermal critical assembly ERMINE of the Minerve reactor at Fontenay-aux-Roses has been used since 1967 for physics experiments on fast multiplying media. Certain calculations had to be made on the adaptation of the two coupled zones in order to prepare and analyze the experiments. The minimum of modification was made to Minerve for these experiments. Safety criteria and flexibility were considered in the choice of auxiliary devices. Experimental techniques used in ERMINE such as fission chamber, foil activation, and oscillation of the sample are briefly described. The experimental results during a one year period of operation (1968), and the experimental analysis already undertaken in the framework of neutron studies applied to fast reactor systems are presented. 31 references. (France)

3943 (COO-2082-3) TECHNICAL PROGRESS REPORT [ON REACTOR UPGRADING, NOVEMBER 30, 1970-JULY 31, 1971]. (Kansas State Univ., Manhattan. Dept. of Nuclear Engineering). 21 Sep 1971. Contract AT(11-1)-2082. 14p. Dep. NTIS.

Irradiation experiments performed in the Kansas State University Reactor during November 1970 to July 1971 are listed. (D.C.C.)

3944 (DOCKET-50231-102) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Technical Specifications, Change No. 8. (Division of Reactor Licensing (AEC), Washington, D. C.). 12 Nov 1971. 22p. Dep. NTIS.

Revised technical specifications are presented concerning personnel responsibilities and administrative controls. (D.C.C.)

3945 (DOCKET-50231-103) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Technical Specifications, Change No. 9. (Division of Reactor Licensing (AEC), Washington, D. C.). 12 Nov 1971. 19p. Dep. NTIS.

Revised technical specifications are presented concerning test requirements before initiating transient testing with Core 2. (D.C.C.)

3946 (EUR-4679(Pt.1)) POWER PULSE FLUCTUATIONS IN THE SORA REACTOR: THEORY. Matthes, W. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1971. 20p. Dep. NTIS (U. S. Sales Only). EUR FF 4.45.

Fluctuations of the power pulses in periodically (reactivity-) pulsed reactors were confirmed experimentally. The necessary analytical methods to describe such phenomena are presented. It turns out that the variance to mean ratio of some fluctuating quantities (e.g., the number of neutron counts in an absorption counter integrated over the power pulse) is power-independent and only a function of the criticality of the reactor. These quantities can therefore be used to determine the criticality of the reactor experimentally. 6 references. (auth)

3947 (EURFNR-950) PHYSICS INVESTIGATIONS OF SODIUM-COOLED FAST REACTORS: SNEAK ASSEMBLY 2. Helm, F.; Jourdan, G.; Pilate, S.; Reichal, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Jun 1971. 136p. (KFK-1399). Dep. NTIS (U. S. Sales Only).

Work performed under United States-Euratom Fast Reactor Exchange Program.

SNEAK Assembly 2 was aimed at measuring physics parameters of a fast sodium cooled breeder core having a number of features typical for the prototype SNR. Particular attention was given to a close simulation of the radial geometry. The three modifications 2A, 2B, and 2C denote respectively a purely uranium fuelled core, a core with a 90 degree sector fuelled with SNEAK plutonium and a core where the 90 degree plutonium sector was extended to about 150 degrees using MASURCA fuel. In the latter configuration an extensive series of experiments with simulated control rods was performed. The experimental results were compared to detailed calculations. (21 references) (auth)

3948 (IFA-FR-81) DETERMINATION OF THE CONCENTRATION OF THE ^{51}Cr ISOTOPE IN THE VVR-S REACTOR COOLING WATER. Ionescu, G.; Ionescu, E.; Alexan, Z. (Institutul de Fizica Atomica, Bucharest (Romania)). 1970. 11p. (In French). Dep. NTIS (U. S. Sales Only).

A method for the quantitative determination of ^{51}Cr in the coolant water of the VVR-S reactor using a series of calibrated sources from the IAEA is described. The method was used to calibrate several ^{51}Cr sources and to measure the ^{51}Cr contamination. 8 references. (J.S.R.)

3949 (INR-1305) DETERMINATION OF STATIC PARAMETERS FOR WWR-SM LATTICES WITH INCREASED WATER-TO-FUEL RATIO. Supplement. Adamski, Leslaw; Jozefowicz, Edward Tadeusz; Jozefowicz, Krystyna (Institute of Nuclear Research, Warsaw (Poland)). 1971. 15p. Dep. NTIS (U. S. Sales Only).

Studies on micro- and macroscopic neutron parameters of WWR-SM reactor lattices are described. The "diluted" lattice 2:1 and new lattice 1:1 are discussed. 6 references. (auth)

3950 (LA-4797) KINGLET SAFETY ANALYSIS. Wimett, T. F.; White, R. H.; Paxton, H. C.; Orndoff, J. D. (Los Alamos Scientific Lab., N. Mex.). Oct 1971. Contract W-7405-eng-36. 112p. Dep. NTIS.

The Kinglet critical assembly, with circulating enriched-uranium solution, is to provide design information for the proposed KING high-flux reactor. The assembly is complete except for introduction of the solution. It is demonstrated that safety features of the critical-assembly facility, features of Kinglet, and the restrictions of Pajarito Operating Limits will effectively protect personnel and the public. (auth)

3951 (NP-19038) NEUTRON TRANSPORT AND THERMALIZATION STUDIES WITH BERYLLIUM OXIDE. Rainbow, M. T. (Tasmania Univ., Hobart (Australia)). Dec 1969. 225p. Dep. NTIS (U. S. Sales Only).

Thesis.

Results of an investigation into the mode of decay of neutron populations in 18 pulsed BeO assemblies with decay constants in the vicinity of $(v\Sigma_{inel})_{min}$ are presented. In assemblies with buckling less than 2.1×10^{-2} cm^{-2} the decay curve could be described as exponential following elapse of a certain waiting time. For 2.1×10^{-2} cm^{-2} < B^2 < 2.91×10^{-2} cm^{-2} the decay curve is exponential within the limits of this determination. In assemblies with $B^2 \geq 3.3 \times 10^{-2}$ cm^{-2} the decay curve cannot be described by an exponential at waiting times > 1.5 msec. At 2.91×10^{-2} cm^{-2} < B^2 < 3.3×10^{-2} cm^{-2} there is a region in which no definite statement can be made regarding the decay mode. The observed upper bound to decay constants is not consistent with the theoretical limit and this is thought to constitute evidence for the existence of population decay associated with a "pseudo-discrete" energy mode. A theory based on the assumption that the neutron flux in a finite moderator assembly may be expanded in terms of Fourier spatial modes was tested using a ^{239}Pu spectral indicator and a B(1/v) detector in a pulsed thermalization experiment. Agreement was good, even after injection of a fast neutron pulse into the large assembly. The Fourier spatial modes of the time-dependent reaction rates of the detectors appeared to exist as separate entities associated with different energy spectra. They were therefore directly comparable with results of zero-dimensional multigroup calculations. The marked nonexponential behavior of that part of the time-dependent response due to the non-1/v part of the ^{239}Pu cross section which reflects the decay of the 0.3 eV neutron population associated with the fundamental Fourier mode indicated that no higher discrete energy modes exist for polycrystalline BeO. (Australia)

3952 (UJV-2534-P) INFORMATION AND CONTROL SYSTEM FOR IRRADIATION EXPERIMENTS ON A MATERIALS TESTING REACTOR. 2. Vavrin, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). [nd]. 21p. (In Czech). INIS.

The design of an information and control system for irradiation experiments on a materials testing reactor is discussed. The system should improve and reduce the experimental procedure: planning of the experiment, data collection, data processing, and the

analysis of results. Two variants are discussed: system Varian 620/i and system Argus 500. Performance of the systems is evaluated and compared. The computer systems are shown to be more advantageous than the conventional technique. Argus 500 or its combination with a large central computer appears to be the most suitable. (INIS)

3953 CRITICALITY MEASUREMENTS ON URANIUM METAL SPHERES IMMERSED IN URANIUM SOLUTION. Hunt, D. C.; Rothe, Robert E. (Dow Chemical Co., Golden, Colo.). Nucl. Sci. Eng.; 46: No. 1, 76-87(Oct 1971).

The results of criticality measurements on enriched (93.16% ^{235}U) uranium metal spheres symmetrically immersed in enriched (93.18% ^{235}U) uranyl nitrate solution cylinders are reported. The solution cylinders are 26.5, 38.4, and 51.1 cm in diameter with heights ranging from 16 to 70 cm. Solution concentrations, expressed in grams of uranium per liter, are 11.47, 12.55, 13.12, 21.25, 24.20, 24.72, 103.0, and 104.8. Twenty-seven critical systems are identified. The experimental critical parameters of each system are compared with computed values obtained by transport (DTF) and Monte Carlo (KENO) methods. Results from neither method exhibit a systematic difference from experimental values; the average difference in the critical radius is 2.5% for DTF and 2.0% for KENO. The effects of experimental perturbations are determined experimentally and calculationally. 18 references. (auth)

3954 MEASURED NEUTRON SPECTRA IN A NUMBER OF URANIUM- AND PLUTONIUM-FUELED REACTOR ASSEMBLIES. Yule, T. J.; Bennett, E. F. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 46: No. 2, 236-43(Nov 1971).

Central neutron spectra were measured with proton-recoil proportional counters in a number of uranium- and plutonium-fueled fast reactor assemblies. The energy range of the measurements is from 1 keV to 2 MeV. Short descriptions are included of the experimental technique and of the correction schemes necessary to remove inherent systematic errors in this method of spectroscopy. The measured neutron spectra are compared with homogeneous fundamental-mode calculated spectra. ENDF/B Version I data were used. In general, the agreement between the measured and calculated spectra is good. The comparisons have revealed some systematic discrepancies which are believed to be outside of experimental error near neutron scattering resonances and at low and high energies. These differences are beyond those associated with heterogeneity effects introduced by the plate loadings of the cores. (auth)

3955 RESPONSE OF THE FFTF EX-VESSEL DETECTORS TO LARGE ^{252}Cf SOURCES. Buhl, A. R.; Childs, R. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 513(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3956 CONTINUOUS ON-LINE MONITORING OF OXYGEN, CARBON, AND HYDROGEN IN SODIUM. Singer, B. (Atomic Energy Commission, Washington, D. C.); Burris, L. Trans. Amer. Nucl. Soc.; 14: No. 2, 608(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3957 DESIGN AND PERFORMANCE OF AN OXYGEN-HYDROGEN METER MODULE FOR ON-LINE SODIUM ANALYSIS AT FFTF. Kolba, V. M.; Slawecki, M. A.; Filewicz, E. C.; Holmes, J. T. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 608-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3958 DESIGN AND TESTING OF A STANDARD DEVICE FOR DETERMINING OXYGEN ACTIVITY IN SODIUM BY VANADIUM WIRE EQUILIBRATION. McKee, J. M.; Kolba, V. M.; Filewicz, E. C.; Holmes, J. T. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 609-10(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3959 EVALUATION OF AN ON-LINE CARBON METER FOR USE IN LMFBR SODIUM. Luner, C.; Holmes, J.; Nelson, P. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 610(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3960 FFTF SODIUM IMPURITY MONITORING AND ANALYSIS: FUNCTION, DEVELOPMENT EFFORTS, AND FACILITY DESIGN. Kolowith, R.; McCown, J. J. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 619-20(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3961 FABRICATION OF AN INSTRUMENTED FUEL ASSEMBLY FOR VIBRATION TESTING. Myers, R. L.; Blahnik, D.; Sawtelle, G. R. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 633-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3962 COMPARISONS OF TWO-DIMENSIONAL KINETICS CALCULATIONS WITH REACTOR EXPERIMENTS. Weaver, Gabriel H.; Graham III, W. Waverly (Georgia Inst. of Tech., Atlanta). Trans. Amer. Nucl. Soc.; 14: No. 2, 642(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3963 SUBCRITICAL EXPERIMENTS WITH MIXED-OXIDE FUELS OF PLUTONIUM AND URANIUM IN POISONED LATTICES. Brown, C. L.; Davenport, L. C.; Clayton, E. D. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: No. 2, 675 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3964 KING REACTOR CONCEPT: ITS DYNAMIC TEST AND SAFETY EVALUATION. King, L. D. P.; Wimett, T. F. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 716-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3965 FLUX OPTIMIZATION FOR A KING REACTOR. Adler, F. T. (Univ. of Illinois, Urbana); Lathrop, K. D. Trans. Amer. Nucl. Soc.; 14: No. 2, 717-18(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3966 SIMULATION OF AN FTR SUBASSEMBLY USING A SMALL TEST BUNDLE. Marr, W. W.; Barts, E. W. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 723 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3967 ATR STARTUP FUEL-PLATE-CLADDING CORROSION TEST: PRELIMINARY DATA AND CONCLUSIONS. Griebenow, M. L.; Hanson, G. H.; Graber, M. J. Jr.; Fjeld, D. S. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc.; 14: No. 2, 761-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3968 PREINITIATION MEASUREMENTS WITH A FAST PULSE REACTOR. Kazi, A. Halim (Army Ballistic Research Labs., Aberdeen Proving Ground, Md.). Trans. Amer. Nucl. Soc.; 14: No. 2, 763-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3969 TRIGA FLIP: A UNIQUE LONG-LIVED VERSION OF THE TRIGA REACTOR. Foushee, F.; Shoptaugh, J. R.; West, G. B.; Whittemore, W. L. (Gulf Energy and Environmental Systems, San Diego, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 764-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3970 ON-LINE DETECTION OF ANOMALOUS REACTIVITY IN THE JMTR. Osawa, Yasuo (Hitachi Ltd., Ozenji, Japan); Kato, Kanji; Shimegi, Nobuo; Iida, Hiromasa. Trans. Amer. Nucl. Soc.; 14: No. 2, 766(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3971 MEASUREMENT OF NOBLE GAS TRANSPORT DYNAMICS IN SEFOR SODIUM. Regimbal, J. J. (General Electric Co., Sunnyvale, Calif.); Kunkel, W. P.; Gilbert, R. S. Trans. Amer. Nucl. Soc.; 14: No. 2, 773-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3972 IRRADIATION ENVIRONMENT IN EBR-II: A COMPARISON OF MEASUREMENTS AND CALCULATIONS. Sehgal, B. R. (Argonne National Lab., Ill.); Kirn, F. S. Trans. Amer. Nucl. Soc.; 14: No. 2, 778-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3973 INVERSE KINETICS TECHNIQUES APPLIED TO ZPPR FAST CRITICAL ASSEMBLIES. Goin, R. W.; Carpenter,

S. G.; Gasidlo, J. M.; Kaiser, R. E. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: No. 2, 794-5 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3974 ANL-FFTF CRITICAL EXPERIMENTS PROGRAM: A GENERAL EVALUATION BASED ON ENDF/B-1 DATA. Travelli, A.; Ulrich, A. J.; Beitel, J. C. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 811-12(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3975 COMPARISON OF MODIFIED ENDF/B-2 AND ABN CROSS-SECTION SETS IN THE ANALYSIS OF FTR CRITICAL EXPERIMENTS. Ramchandran, S.; Koudelka, A. J.; Madden, G. H. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 812-13(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3976 INTEGRAL ALPHA MEASUREMENTS FOR U AND Pu ISOTOPES IN EBR-II. Dudey, N. D.; Heinrich, R. R.; Williams, J. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 816-17(Oct 1971).

From Joint meeting of the American Nuclear Society, Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3977 SENSITIVITIES OF CAPTURE-TO-FISSION RATIOS OF U AND Pu ISOTOPES IN EBR-II CORE AND BLANKET REGIONS FOR VARIOUS LOADINGS. Meneghetti, D.; Rempert, R. H. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 817-18(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3978 EFFECTS OF SODIUM VOIDING ON REACTOR PARAMETERS IN THE DEMONSTRATION REACTOR. Kaiser, R. E.; Forrester, R. J.; Norris, R. J.; Hess, A. L. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: No. 2, 843(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3979 SODIUM VOIDING STUDIES IN THE DEMONSTRATION PLANT BENCHMARK CRITICAL (ZPPR-2). Olson, Arne P.; Young, Jay C.; Vosburgh, Robert O. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: No. 2, 843-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3980 ANALYSIS OF THE SMALL-SAMPLE DOPPLER MEASUREMENTS IN ZPR-6 ASSEMBLIES 6 AND 7. Kier, P. H.; Salvatores, M.; Robinson, W. R.; Dance, K. D. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 844-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3981 ANALYSES OF SMALL-SAMPLE DOPPLER EXPERIMENTS IN SUPPORT OF THE FTR DESIGN. Ramchandran, S.; Koudelka, A. J.; Madden, G. H. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 845-6 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3982 CALCULATED SIZE EFFECTS FOR REACTIVITY SAMPLES IN ZPPR. Collins, P. J.; Palmer, R. G. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc.; 14: No. 2, 846-7(Oct 1971).

From Joint meeting of tne American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3983 MEASUREMENTS AND CALCULATIONS OF A SIMULATED HIGH WORTH CONTROL ROD FOR EBR-II. Stenstrom, D. G. (Argonne National Lab., Ill.); Vosburgh, R. O.; Gasidlo, J. M.; Keeney, W. P.; Meneghetti, D. Trans. Amer. Nucl. Soc.; 14: No. 2, 847-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3984 COMPARATIVE STUDY OF HETEROGENEITY TREATMENTS FOR ZPR PLATE CELLS. Zolotar, B. A. (Argonne National Lab., Ill.); Salvatores, M.; Bingman, B. M.; Lewis, E. E. Trans. Amer. Nucl. Soc.; 14: No. 2, 848-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3985 COMPARATIVE ANALYSIS OF METHODS FOR CALCULATING HETEROGENEITY EFFECTS IN FAST CRITICAL ASSEMBLIES. PART I. METHODS. Mueller, R. E. (Atomic Power Development Associates, Inc., Detroit); Page, E. M.; Komata, M. Trans. Amer. Nucl. Soc.; 14: No. 2, 849-50(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3986 COMPARATIVE ANALYSIS OF METHODS FOR CALCULATING HETEROGENEITY EFFECTS IN FAST CRITICAL EXPERIMENTS. PART II. ANALYSIS. Page, E. M.; Mueller, R. E. (Atomic Power Development Associates, Inc., Detroit). Trans. Amer. Nucl. Soc.; 14: No. 2, 851-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3987 SPACE- AND ENERGY-DEPENDENT REACTOR NOISE MEASUREMENTS. Penland, J. R. (Babcock and Wilcox, Lynchburg, Va.); Ackermann, N. J. Jr.; Hanauer, S. H. Trans. Amer. Nucl. Soc.; 14: No. 2, 854-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3988 EXPERIENCE WITH SUBCRITICALITY DETERMINATION BY NOISE TECHNIQUES IN THE FTR ENGINEERING-MOCKUP CRITICAL EXPERIMENT PROGRAM. Cohn, Charles E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 861(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3989 PULSED-SOURCE EXPERIMENTS IN A REFLECTED COUPLED-CORE REACTOR. McDonnell, F. N.; Harris, M. J. (Univ. of Manchester, Eng.). Trans. Amer. Nucl. Soc.; 14: No. 2, 864-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3990 PAINT TO REDUCE ^{41}Ar RELEASE AND RESIDUAL ACTIVITY IN A REACTOR EXPOSURE VOLUME. Leonard, B. E. (Nuclear Systems Associates, Inc., Bethesda, Md.); McManaman, V. L. Trans. Amer. Nucl. Soc.; 14: No. 2, 893-4 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3991 SHIELDING THE FAST FLUX TEST FACILITY (FFTF). Rathbun, J. L. (Westinghouse Electric Corp., Madison, Pa.); Gerstl, S. A. W.; Fox, P. F.; Bunch, W. L.; Boulette, E. T. Trans. Amer. Nucl. Soc.; 14: No. 2, 934-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3992 FFTF RELATED STUDIES IN THE ORNL-LMFBR SHIELDING PROGRAM. Mynatt, F. R. (Oak Ridge National Lab., Tenn.); Clifford, C. E.; Muckenthaler, F. J.; (and others). Trans. Amer. Nucl. Soc.; 14: No. 2, 935-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3993 CONSTRUCTION AND PERFORMANCE OF THE LIQUID METHANE COLD SOURCE. Dimic, V.; Petkovsek, J. (Jozef Stefan Inst., Ljubljana, Yugoslavia). J. Phys., E (London); 4: No. 11, 905-8(Nov 1971).

A liquid methane cold source was installed in one of the tangential beam tubes of the reactor TRIGA Mark II at the "Jozef Stefan" Institute and gave continuous and reliable service. The design and construction of the cooling system and cold source assembly are described and some graphs showing the performance are given. (auth) (UK)

3994 DYNAMIC THERMAL STRESSES IN A PULSED REACTOR. Parkes, E. W.; Carter, G. A. (Cambridge Univ., Eng.). Phil. Trans. Roy. Soc. London, Ser. A; 270: No. 1205, 325-47(14 Oct 1971).

The reasons why dynamic thermal stresses are rarely encountered are considered and the three means by which they may most readily be produced are discussed: large electric currents, impulsive electromagnetic radiation and neutron bombardment of fissile material. This is followed by a brief description of the pulsed reactor Viper and by theoretical solutions for the elastic displacements and stresses in slender cylinders and cones when rapidly heated. The physical properties of enriched uranium are discussed and experiments on cylinders and cones of this material when subjected to large neutron pulses in Viper, including the problems of measurement in the hostile environment are described. Agreement between the theoretical and experimental displacements is good. (auth) (UK)

Rocket and Space Reactors

Refer also to abstracts 1984, 2082, and 3078.

3995 (N-71-28092) EXPERIMENTAL EVALUATION OF SNAP-8 POWER CONVERSION SYSTEM START-UP. Hurrell, Herbert G.; Soeder, Ronald H.; Lottig, Roy A.; Jefferies, Kent S. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jun 1971. 25p. (NASA-TN-D-6381). NTIS.

The SNAP-8 power conversion system is turboelectric and operates on the mercury Rankine cycle. A startup test program was conducted on the power conversion system using a reactor simulator and a radiator simulator. Data from this program are presented and discussed. The data show that the power conversion system startup is dependable and that the resultant reactor temperature transients are well within the specified constraints. (auth) (STAR)

3996 MODERATED THERMIONIC REACTOR CORE. Hobson, Robert R.; Scott, Robert N.; Hill, Paul R. (to United States Atomic Energy Commission). U. S. Patent 3,607,631. 21 Sep 1971. Filed 6 Nov 1968.

A moderated thermionic core assembly has been provided which employs vapor chamber condenser-cooled stacked thermionic fuel elements. A cylindrical moderator block is provided with a plurality of radial wells drilled in an ordered array about the periphery of the moderator block. Each well is adapted to receive a tubular fuel element which includes two series-connected nuclear fueled thermionic converter elements having a neutral plasma maintained between the emitter and collector electrodes of each converter. Each fuel element includes a vapor chamber condenser which extracts excess heat from the collectors and transmits it to an external reflector from which the excess heat is radiated to space. (auth)

3997 REUSABLE NUCLEAR STAGE DESIGN CONCEPTS. Johnson, Paul G. (National Aeronautics and Space Administration, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 421(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3998 NERVA FLIGHT ENGINE DESIGN CONCEPT. Corrington, L. C. (Space Nuclear Systems Office, Cleveland). Trans. Amer. Nucl. Soc.; 14: No. 2, 421-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

3999 NUCLEAR DESIGN OF THE NERVA NUCLEAR SUBSYSTEM. Doncals, R. A.; Kovacik, W. P. (Westinghouse Astronuclear Lab., Large, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 422-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4000 RADIATION DESIGN OF THE NERVA NUCLEAR SUBSYSTEM. Capo, M. A.; Kovacik, W. P. (Westinghouse Astronuclear Lab., Large, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 423-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4001 NERVA FLIGHT ENGINE CONTROL SYSTEM DESIGN. Norman, H. H. (Westinghouse Electric Corp., Sacramento, Calif.); Parziale, E. A.; Saluja, J. K.; Schenz, R. F. Jr. Trans. Amer. Nucl. Soc.; 14: No. 2, 424-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4002 NERVA PROPULSION/ELECTRICAL POWER GENERATION DESIGN FEASIBILITY STUDY. Black, D. L. (Westinghouse Astronuclear Lab., Large, Pa.). Trans. Amer. Nucl. Soc.; 14: No. 2, 425-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4003 MINI GAS-CORE PROPULSION CONCEPT. Hyland, Robert E. (Space Nuclear Systems Office, Cleveland). Trans. Amer. Nucl. Soc.; 14: No. 2, 428(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4004 SPLIT-CORE HEAT-PIPE REACTORS FOR OUT-OF-PILE THERMIONIC POWER SYSTEMS. Niederauer, George F.; Lantz, Edward; Breitwieser, Roland (Space Nuclear Systems Office, Cleveland). Trans. Amer. Nucl. Soc.; 14: No. 2, 433(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4005 DYNAMICS OF HEAT-PIPE REACTORS. Niederauer, George F. (Space Nuclear Systems Office, Cleveland). Trans. Amer. Nucl. Soc.; 14: No. 2, 433-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4006 SIZING AN EXTERNAL-FUELED IN-CORE THERMIONIC REACTOR FOR SYSTEM DESIGN. Sawyer, C. D.; Nakashima, A. M. (California Inst. of Tech., Pasadena). Trans. Amer. Nucl. Soc.; 14: No. 2, 434-5(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4007 NUCLEAR SPACE POWER SYSTEMS CAN BE COST EFFECTIVE. Carpenter, Robert T. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 540(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4008 REACTORS FOR ELECTRIC POWER IN SPACE. Johnson, Carl E. (National Aeronautics and Space Administration, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 542(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4009 TECHNOLOGY OF NUCLEAR-BRAYTON SPACE POWER SYSTEMS. English, Robert E. (Space Nuclear Systems Office, Cleveland). Trans. Amer. Nucl. Soc.; 14: No. 2, 542(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4010 APPLICATIONS OF REACTOR POWER SYSTEMS TO ELECTRIC PROPULSION MISSIONS. Sawyer, C. D. (California Inst. of Tech., Pasadena); Schaupp, R. W. Trans. Amer. Nucl. Soc.; 14: No. 2, 542-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4011 LOS ALAMOS MONTE CARLO CRITICALITY CODE FOR ROVER REACTOR CALCULATIONS. Watson, Clayton W. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 647(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4012 DYNAMICS MODEL OF THE COAXIAL FLOW GASEOUS CORE NUCLEAR REACTOR. Turner, K. H. Jr.; Clement, J. D. (Goergia Inst. of Tech., Atlanta). Trans. Amer. Nucl. Soc.; 14: No. 2, 794(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4013 EFFECT OF ANGULAR QUADRATURE ON RESULTS OF SPACE POWER REACTOR SHIELD CALCULATIONS. Connolley, D. J.; Lahti, G. P. (Space Nuclear Systems Office, Cleveland, Ohio). Trans. Amer. Nucl. Soc.; 14: No. 2, 929(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Process Heat and Desalination Reactors

4014 (ORNL-NDIC-11) TITLE-AUTHOR-COMPANY INDEX TO REPORTS PUBLISHED BY THE U.S. DEPARTMENT OF THE INTERIOR, OFFICE OF SALINE WATER THROUGH JULY 1971. Johnsson, K. O. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 90p. Dep. NTIS.

A permuted index of the titles, authors, companies, and numbers of the approximately 700 research and development progress reports issued by the Office of Saline Water, U.S. Department of the Interior, through July 1971. The index was prepared with the aid of a computer and is presented in the form of computer printout. (auth)

4015 USE OF HIGH TEMPERATURE NUCLEAR HEAT IN THE CHEMICAL AND STEEL INDUSTRIES. Siebker, M.; Martin, H. (Commission of the European Communities, Brussels). Energ. Nucl. (Paris); 13: No. 4, 275-83(Jul 1971). (In French).

The energy situation in the E.A.E.C. is reviewed from a general standpoint, the strong dependence upon imports being emphasized: the current problems existing in the crude oil and coke markets are stressed. The possible utilization of the nuclear heat produced

by HTGR's is examined. An energy center is envisaged, where nuclear heat could be used to produce certain basic chemical materials, such as hydrogen, and other gases, from the oxidation of fossil fuels. Another idea discussed is that of an integrated nuclear/steel industry in which an HTGR could provide all the energy required for the three stages involved in the production of crude steel: the thermal energy for producing the reducing gas, and for reducing the iron ore, and the electrical energy for refining the sponge iron. (France)

Marine and Portable Power Reactors

4016 NUCLEAR-POWERED AIR-CUSHION FREIGHTER FOR THE 1980's. Anderson, John L.; Finnegan, Patrick M. (Space Nuclear Systems Office, Cleveland). Trans. Amer. Nucl. Soc.; 14: No. 2, 455-6(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Production Reactors

4017 FUEL MANAGEMENT IN A HIGH FLUX PRODUCTION REACTOR FOLLOWING UNSCHEDULED SHUTDOWNS. Benton, F. D.; Topp, S. V. (E. I. duPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc.; 14: No. 2, 494-5(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Reactor Theory

4018 SYNTHESIS: PAST AND PRESENT. Kaplan, S. (Computer Sciences Corp., El Segundo, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 636(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4019 OPTIMAL CONTROL OF A SPATIALLY DEPENDENT NUCLEAR REACTOR. Specker, Steven R. (Tennessee Valley Authority, Chattanooga); Danofsky, Richard A. Trans. Amer. Nucl. Soc.; 14: No. 2, 645-6(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4020 MONTE CARLO SIMULATION OF MULTIGROUP TRANSPORT CROSS SECTIONS. Harris, D. R. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 647-8(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4021 PROBABILITY TABLE METHOD FOR TREATING UNRESOLVED RESONANCES IN MONTE CARLO CRITICALITY CALCULATIONS. Levitt, L. B. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 648-9(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4022 APPLICATION OF THE PROBABILITY TABLE METHOD OF TREATING UNRESOLVED RESONANCES TO AN ANALYTICAL CALCULATION. Otter, J. M. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 649-50(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4023 HETEROGENEOUS TREATMENT OF FUEL ASSEMBLY BOUNDARIES IN NODAL DIFFUSION CALCULATIONS. Choong, Philip T.; Soodak, Harry (Gulf United Nuclear Fuels Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 650-1(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4024 TRANSPORT SOLUTIONS USING FINITE ELEMENTS IN SPACE-ANGLE PHASE SPACE. Miller, W. F. Jr.; Lewis, E. E.; Rossow, E. C. (Northwestern Univ., Evanston, Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 651-2(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4025 NONAZIMUTHALLY SYMMETRIC TRANSPORT PROBLEMS IN SLAB GEOMETRY. Hill, T. R.; Shultis, J. K.; Mingle, J. O. (Kansas State Univ., Manhattan). Trans. Amer. Nucl. Soc.; 14: No. 2, 652-3(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4026 MULTIPLE FOIL ACTIVATION SPECTRUM DETERMINATION USING A NUMERICAL DIRECT SEARCH TECHNIQUE. Draper, E. L.; Bouchey, G. D.; Koen, B. V.; Beightler, C. S. (Univ. of Texas, Austin). Trans. Amer. Nucl. Soc.; 14: No. 2, 667-8(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4027 THERMALIZATION WITH SYNTHETIC KERNELS AND LINEAR ANISOTROPIC FIRST-FLIGHT PROBABILITIES. Royl, P. (Univ., Stuttgart). Trans. Amer. Nucl. Soc.; 14: No. 2, 669-70(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4028 SOURCE OF ERROR IN THE CALCULATION OF MATERIAL REACTIVITY WORTHS BY MULTIGROUP PERTURBATION THEORY. Laperches, C.; Almenas, K. (Univ. of Maryland, College Park). Trans. Amer. Nucl. Soc.; 14: No. 2, 671(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4029 GENERALIZED UNIT CELL CALCULATION FOR LUMPED POISONS. Naft, Barry N. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc.; 14: No. 2, 672-3(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4030 DIFFICULTY IN COMPUTING THE K-EFFECTIVE OF THE WORLD. Whitesides, G. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 680(Oct 1971).
From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4031 MINIMUM LOSS OF MAXIMUM POWER IN XENON SHUTDOWN. Salo, S. (Helsinki Univ. of Tech., Ontaniemi, Finland). Ann. Acad. Sci. Fenn., Ser. A VI; No. 375, 1-24(1971).
Pontryagin's optimum theory was applied to the xenon shutdown problem. The performance criterion chosen is based on a flux integral, an effort is made to minimize the perturbation from normal operating conditions in the flux integral. It is shown that the solution is not the one suggested by Rosztoczy. The optimal control is not bang-bang even in the unrestricted case. Numerical results are calculated for a reactor of $\phi_{max} = 4.10^{13}$ n/cm²s with the full power equilibrium state as the initial state. The optimum is compared with the suggestion by Rosztoczy. (auth) (FINLAND)

4032 OPTIMAL CONTROLS FOR XENON SHUTDOWN PROBLEMS IN BORON CONTROLLED REACTORS. Salo, S. (Helsinki Univ. of Tech., Ontaniemi, Finland). Ann. Acad. Sci. Fenn., Ser. A VI; No. 376, 1-36(1971).
Pontryagin's optimum theory is applied to the problem of determining a flux shutdown program that limits xenon poisoning with minimum cost in a reactor, where the amount of excess reactivity depends on the amount of boron present in the core of the reactor. Solutions are found for both the problem of minimum time and the problem of minimum loss of maximum power. Minimum time solutions appear to be similar to those in rod controlled reactors, but some of the problems of minimum loss of maximum power appear to be fixed end time problems. (auth) (FINLAND)

4033 CONCEPT OF ENERGY-DEPENDENT BUCKLING IN MULTI-GROUP DIFFUSION THEORY. I. Beynon, T. D. (Univ. of Birmingham, Eng.). J. Nucl. Energy; 25: No. 10, 503-11(Oct 1971).
By considering the energy multi-group (or energy multi-point) neutron diffusion equation a technique is developed which allows an energy-dependent buckling to be defined. Expanding the scalar flux in terms of the eigensolutions of the Helmholtz equation produces a linear set of strongly coupled differential equations for the various spatial modes in a given energy group. Each mode has an associated buckling which is a function of the particular energy group. The approximation of representing the flux by a single spatial mode produces a simple modification to the usual diffusion equation. (auth) (UK)

Kinetics

Refer also to abstracts 3506, 3540, 3657, 3754, 3773, 3799, 3800, and 3987.

4034 (BNL-50296) ENDF/B PROCESSING CODES FOR THE RESONANCE REGION. Bhat, M. R. (Brookhaven National Lab., Upton, N. Y.). Jun 1971. 181p. (ENDF-148). Dep. NTIS.

Six programs written for calculating point-wise cross-sections in the resolved and unresolved resonance region are presented. These programs have been written specifically to read in the resonance parameters in the ENDF/B files. However, the smooth cross-sections from File 3 have to be added to the output of these programs to obtain the final cross-section. Out of the six codes described the first four calculate the cross sections in the resolved resonance region and the last two in the unresolved resonance region. The first program SIGPLOT calculates cross-sections for scattering, capture and fission using the single level Breit–Wigner parameters of ENDF/B Version I data. It also calculates multi-level scattering cross-sections. The cross-sections may be Doppler broadened if necessary. The second program SIGMA2 is essentially a modified version of SIGPLOT written for ENDF/B Version II data. The third program RAMP1 calculates scattering, capture and fission cross-sections using the Reich–Moore approximation, with or without Doppler broadening. The next program ADLER calculates cross-sections from the Adler–Adler parameters. Doppler broadening is done using the ψ and χ functions. AVRAGE3 and AVRAGE4 calculate cross-sections in the unresolved region using energy independent parameters and energy dependent parameters of ENDF/B Version II respectively. Width-fluctuation corrections are applied by numerical integration. Also, there is no provision made for allowing any inelastic effects in AVRAGE3 whereas they are taken into account in the latter program. The program listings with sample input data and results of the test problems are presented. (10 references) (auth)

4035 (EUR–4678) MONTE CARLO SIMULATION OF THE ADJOINT TRANSPORT EQUATION. Matthes, W. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1971. 44p. Dep. NTIS (U. S. Sales Only). EUR FF 6.65.

Usually one starts from the adjoint transport equation to construct a Monte Carlo method for its simulation. This procedure requires a sophisticated reasoning to find out which quantity of the method is adjoint to what. Contrary to this point of view two independent methods of two different kinds of particles are used with the condition that the expectation value of some estimator in the two methods should be equal. This leads directly to the Monte Carlo method for the adjoint flux. This method is applied to the calculation of the neutron flux in an annular air gap in the water shield of a cylindrical reactor. 5 references. (auth)

4036 (EURFNR–927) THE DTK ONE-DIMENSIONAL TRANSPORT PROGRAM. Guenther, C.; Kinnebrock, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of report KFK–1381. 51p. Dep. NTIS.

Work performed under United States–Euratom Fast Reactor Exchange Program.

DTK is a FORTRAN-4 program for solving the multigroup one dimensional (plane, sphere, cylinder) transport equation by the methods of discrete ordinates. It has been developed from the code DTF-IV. DTK differs from the DTF-IV code essentially in the following features: the input has been simplified; DTK has "interfaces" with the program system NUSYS; a new nonconstant initial source guess has been built in; a variety of buckling options has been incorporated; in plane geometry the user may prescribe the incoming energy- and space-dependent flux at the right boundary; Tchebychew extrapolation for the outer iteration has been built in; and it is possible to pass fluxes from one case to the other. Use of the code and a code listing and a sample input are included. (auth)

4037 (FEI–223) COMPUTING INTRA-GROUP AVERAGE VOLUMETRIC SPECTRA OF SLOWING-DOWN NEUTRONS IN A HYDROGENOUS REACTOR. Gurin, V. N.; Dmitrieva, V. S.; Rumyantsev, G. Ya. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1970. 24p. (In Russian). INIS.

An algorithm is proposed for group average volume equations for neutron moderation with a P_1-approximation. A program is written for use with the M-20 computer. An example of calculation of a core neutron spectrum is presented. The core contained a homogeneous mixture of H, ^{235}U, O, C, and stainless steel. (tr-auth)

4038 (KFK–1349) APPROXIMATION OF THE STATIONARY THREE-DIMENSIONAL MANY-GROUP NEUTRON-DIFFUSION EQUATION THROUGH A SYNTHESIS METHOD WITH THE KARLSRUHE SYNTHESIS PROGRAM KASY. Buckel, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Jun 1971. 143p. (In German). Dep. NTIS (U. S. Sales Only).

The Karlsruhe Synthesis Programme KASY written in FORTRAN IV for the IBM 360/65 and larger models approximately solves the energy-group dependent three-dimensional neutron diffusion equation by a synthesis method. Catalogued two-dimensional trial functions are used for the calculation. A short description of the mathematical background of the variational principle used in the synthesis method is given. The contents and the structure of the programme KASY are explained. Some results are discussed. The results obtained by the programme KASY are compared with results from two-dimensional and three-dimensional fully numerical calculations. An extensive analysis of the sodium cooled reactor Na2 with 5-, 12- and 26 group representation shows the possibilities and the limits of KASY. 21 references. (auth)

4039 RECENT RESEARCH ON SPACE-ENERGY SYNTHESIS AT PURDUE UNIVERSITY. Ott, K. O. (Purdue Univ., Lafayette, Ind.). Trans. Amer. Nucl. Soc.; 14: No. 2, 636-7 (Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4040 REVIEW OF SPATIAL AND SPECTRAL FLUX SYNTHESIS METHODS. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: No. 2, 637(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4041 SPACE-ENERGY SYNTHESIS METHOD FOR TWO-DIMENSIONAL NEUTRON DISTRIBUTIONS IN LARGE FAST BREEDER REACTORS. Torri, A.; Hansen, K. F.; Mason, E. A. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc.; 14: No. 2, 637-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4042 APPLICATIONS OF ITERATIVE AND SUCCESSIVE SPACE-ENERGY SYNTHESIS TO FAST REACTOR PROBLEMS. Savio, R. P. (Argonne National Lab., Ill.); Ott, K. O.; Meneley, D. A. Trans. Amer. Nucl. Soc.; 14: No. 2, 638-9(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4043 EXACT PERTURBATION THEORY IN SYNTHESIS CALCULATIONS. Savio, R. P. (Argonne National Lab., Ill.); Ott, K. O.; Meneley, D. A. Trans. Amer. Nucl. Soc.; 14: No. 2, 639-40(Oct 1971).

From Joint meeting of the Ameran Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4044 METHODS FOR DEALING WITH THE TIME BEHAVIOR OF REACTOR KINETICS EQUATIONS. Henry, A. F. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc.; 14: No. 2, 641-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4045 HYBRID COMPUTATION OF SPATIAL REACTOR KINETICS INCLUDING FEEDBACK. Schultz, Kenneth R. (Gulf General Atomic, San Diego, Calif.); Bullock, Thomas E.; Ohanian, M. J. Trans. Amer. Nucl. Soc.; 14: No. 2, 642-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4046 ACCELERATED SOLUTION OF THE THERMAL-NEUTRON BALANCE EQUATION. Walti, P.; Koch, P. K. (Gulf General Atomic, San Diego, Calif.). Trans. Amer. Nucl. Soc.; 14: No. 2, 665-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4047 HYBRID ITERATION SCHEME FOR BWR NODAL CALCULATIONS. Choong, P. T. (Gulf United Nuclear Fuels Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc.; 14: No. 2, 666(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4048 MARK MILLS AWARD WINNING PAPER: THE DEGENERATE KERNEL TECHNIQUE IN NEUTRON THERMALIZATION CALCULATIONS. Turinsky, Paul J. (Univ. of Michigan, Ann Arbor). Trans. Amer. Nucl. Soc.; 14: No. 2, 669(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4049 METHOD FOR VERIFYING REACTIVITY FEEDBACK TIME RESPONSE IN POWER REACTORS. Fry, D. N. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 792-3(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4050 EFFECT OF RANDOMLY VARYING MACROSCOPIC PARAMETERS ON THE STABILITY OF POWER REACTORS: SPACE-INDEPENDENT MODELS. Krist, G. A. (Westinghouse Electric Corp., West Mifflin, Pa.); Poncelet, C. G. Trans. Amer. Nucl. Soc.; 14: No. 2, 793-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4051 THERMAL-NEUTRON SPECTRUM MEASUREMENT BY TIME CORRELATION METHOD. Takahashi, H. (Brookhaven National Lab., Upton, N. Y.); Chandramoleswar, K.; Windsor, H.; Phelps, J.; Conant, J. Trans. Amer. Nucl. Soc.; 14: No. 2, 795-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4052 ASYMPTOTIC DIFFUSION PLUS BOUNDARY PERTURBATION SOLUTION TO THE TRANSPORT EQUATION. Beghian, L. E.; Forbes, I. A.; Rogers, V. C. (Lowell Technological Inst., Mass.). Trans. Amer. Nucl. Soc.; 14: No. 2, 830-1(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4053 SPACE- AND ENERGY-DEPENDENT, FOUR-NODAL POINT NEUTRON FLUCTUATION THEORY. Ackermann, N. J. Jr. (Oak Ridge National Lab., Tenn.); Penland, J. R.; Hanauer, S. H. Trans. Amer. Nucl. Soc.; 14: No. 2, 854(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4054 ENERGY-DEPENDENT ANALYSIS OF NEUTRON WAVE PROPAGATION IN FAST MULTIPLYING MEDIA. Swander, J. E.; Mockel, A. J. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc.; 14: No. 2, 865-6(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4055 INFLUENCE AND USE OF GAMMA RADIATION IN REACTOR NOISE. Baers, Bruno (Helsinki Univ. of Tech., Ontaniemi, Finland). Acta Polytech. Scand., Phys. Nucl. Ser.: No. 79, 1-33(1971).

The influence and use of gamma radiation in reactor noise measurements is studied based on a space- and energy-independent reactor and detector model. The approach is based on the forward Kolmogorov equation and is carried out in a consistent and unified way. The influence of correlated and noncorrelated photon radiation and the influence of a large number of reactor and detector characteristics on the variance of the cumulative number of signal units, on correlation functions and on power spectra associated with the detector signals are explicitly given. The detection model includes the main detector types such as pulse detectors and compensated ionization chambers where the detection is based on absorption, recoil or fission. The model can be used for interpretation of noise measurements in gamma fields. It also reveals that the use of gamma sensitive or combined neutron and gamma sensitive detectors in principle makes it possible to extract additional information from noise measurements compared to measurements with purely neutron sensitive detectors. (auth) (FINLAND)

Dynamics

4056 METODY TEORII USTOICHIVOSTI V DINAMIKE YADERNYKH REAKTOROV. (Stability Theory in Nuclear Reactor Dynamics). Goryachenko, V. D. Moscow; Atomizdat (1971). 264p.

A comprehensive survey of the various methods, criteria, and theories of nuclear reactor stability is presented. Several chapters focus attention on Lyapunov's Second Method for determining stability. Basic stability concepts are applied to different mathematical models of nuclear reactors, and non-linear equations of reactor dynamics are stressed. In addition to a listing of pertinent references at the end of each chapter, a chronological arrangement of 352 references in the back of the book provides a literature coverage through 1970. (K.S.W.)

4057 PYRAMID ALGORITHM IN THE HYBRID SOLUTION OF THE SPACE-TIME-DEPENDENT DIFFUSION EQUATION. Saphier, D. (Soreq Nuclear Research Center, Yavne, Israel). Trans. Amer. Nucl. Soc.; 14: No. 2, 643-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4058 COMPUTATION OF STABILITY DOMAIN OF NONLINEAR SPACE-TIME REACTOR DYNAMICS. Yu, Dahsoong (Univ. of Oklahoma, Norman); McCarty, John R. Trans. Amer. Nucl. Soc.; 14: No. 2, 791-2(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Experimental Applications

4059 (JUL-780-RE) INVERSE KINETIC REACTIVITY MEASUREMENT ON NUCLEAR REACTORS. Kalker, Karl-Josef (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Forschungsreaktoren). Aug 1971. 89p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

4060 (LIB/Trans-325) INTERPRETATION OF CRITICAL EXPERIMENTS WITH URANIUM-PLUTONIUM FUEL ELEMENTS. Naudet, R. Translated by P. Newton (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from IAEA Meeting on Fuel Burnup Predictions in Thermal Reactors, Vienna, Austria, April 10-14, 1967. 23p. (CONF-670418-3). Dep. NTIS (U. S. Sales Only).

A set of critical experiments performed successively in the heavy-water pile AQUILON II and the graphite pile CESAR was designed to compare the neutron properties of the two lattices, which are geometrically identical but in which the fuel composition is slightly different. The same fuel elements were used in the two piles, i.e., uranium metal rods of uniform diameter. The following compositions were compared: Control set: natural uranium; Set used as an intercomparison standard: uranium very slightly depleted or enriched in ^{235}U (0.69-0.83%-0.86%); Three sets to be studied containing plutonium: 1P: natural uranium + 0.04% plutonium; 2P: highly depleted uranium + 0.30% plutonium; 3P: similar to 1P but with plutonium containing a higher proportion of the isotope ^{240}Pu. In AQUILON the experiments were performed over a whole series of lattice spacings so as to vary the spectrum over a wide range, but all the measurements, with one exception, were made at environmental temperature. In CESAR, the experiments involved only one or two spacings, but a wide range of temperature. Measurements were made at 20, 100 and 200°C, and will be continued at 300 and 400°C. The purpose of the experiments is to obtain data on which to evaluate the equivalence between ^{235}U and plutonium in conditions similar to those encountered in natural uranium reactors during irradiation, and to test the calculation methods. The experiments performed in AQUILON are described in greater detail, but the results already obtained in CESAR are also indicated by way of comparison. (auth)

4061 EFFECTIVE RESONANCE INTEGRALS OF FUEL ELEMENTS CONTAINING A MODERATOR IN INTERNAL CAVITIES. Shvedov, O. V.; Belkin, V. F.; Popkov, V. N. pp 176-80 of Byulleten' Informatsionnogo Tsentra po Yadernym Dannym. /Leipunskii, A. I. (ed.). Moscow; Atomizdat (1968). (In Russian).

In 1965, the authors measured the resonance integral of fuel elements that contained a good moderator in internal cavities, such as water, monoisopropylbiphenyl, or Plexiglas. Their results were a few percent lower than those of Hellstrand, obtained a few years earlier. In Hellstrand's work a thin gold foil served as a neutron flux monitor facing a uranium block. The geometry was such that the gold foil recorded a flux incident on the block, but was not sensitive to a stream of neutrons coming from the block. Consequently, the appearance of an internal neutron flux resulting from the presence of the internal moderator did not increase the activity of the foil. The present authors used a supplementary uranium insert as a monitor, so that there existed the possibility of an increase in monitor activity where the moderator was present. It was found that, by carefully controlling the dimensions of the insert, agreement of calculated and experimental data could be obtained. (K.S.W.)

4062 LIBRARY OF EVALUATED INTEGRAL NEUTRON EXPERIMENTS. Hampel, Viktor E. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc.; 14: No. 2, 673-4(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4063 HIGHLY ENRICHED URANIUM METAL SPHERE ASSEMBLY. Mihalczo, J. T. (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc.; 14: No. 2, 675-7(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

4064 UNREFLECTED ^{235}U C_{182} CRITICAL ASSEMBLY. Hoogterp, J. Carlton; Hansen, Gordon E. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: No. 2, 677-8(Oct 1971).

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971). See CONF-711009.

Reactor Components, Fuels, and Accessories

Refer also to abstracts 2031, 2036, 2060, 2116, 2135, 2142, 2160, 2166, 2189, 2193, 2325, 2342–2344, 2346, 2514, 2573, 2579, 2581, 2584, 2585, 2593, 2621, and 2636.

4065 (AECL–3798) THERMOCOUPLES FOR SURFACE TEMPERATURE MEASUREMENT IN MULTIELEMENT NUCLEAR FUEL BUNDLES. Flemons, R. S.; Lane, A. D. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Jun 1971. 27p. (CONF-710604–3). Dep. NTIS (U. S. Sales Only). AECL $1.00.

From fifth symposium on temperature; Washington, D. C. (21 Jun 1971).

The development of nuclear fuels for the Canadian Power Reactor Program has been supported by an extensive program of surface temperature measurement on experimental fuel assemblies. Miniature, mineral-insulated, stainless steel sheathed, thermocouples are attached by brazing to various zirconium alloy and stainless steel fuel sheaths. Fuel assemblies instrumented in this way have been used to: detect dryout in boiling water coolants; measure sheath temperatures in organic coolants, superheated steam, and post-dryout boiling water; and investigate the effect of fouling deposits. The advantages of this type of thermocouple attachment are that it minimizes the degree to which the instrumented element must deviate from a prototypical fuel element and it can be accommodated in close packed multielement fuel bundles. Three methods of attachment are described. One uses a thin cover with a streamlined recess for the thermocouple. A second mounts a severely flattened thermocouple with a solid tip. The third buries thermocouples within the fuel sheath wall. In each case the aim is to minimize the disturbance of coolant flow and the perturbation of temperature distribution caused by the presence of the thermocouple. The attachment techniques are described including methods of braze alloy placement, heating and temperature control. Data on in-reactor performance are included. 9 references. (auth)

4066 (EUR–4556) ANALYTICAL METHOD FOR REPRESENTING CYLINDRICAL B_4C ABSORBERS IN TWO-DIMENSIONAL DIFFUSION CALCULATIONS. Rama, P. G.; Claps, M. (European Atomic Energy Community. FIAT, Turin (Italy). ANSALDO S.p.A., Genoa (Italy)). 12 Jan 1971. 38p. (In Italian). Dep. NTIS (U. S. Sales Only). EUR Lit. 750,-.

Since the 1/V curve of the epithermal collision cross-sections of boron do not pose the difficulties inherent in the treatment of resonances, an analytical method has been developed for calculating the efficiency of B_4C cluster rods, its validity being checked by examining critical experiments performed in the presence of B_4C absorbers. Comparison of the calculated and measured values shows that the computation method described here is valid to an error of 4 to 5% for estimating the efficiency of B_4C clusters. 13 references. (auth)

4067 (FEI–220) BURNUP OF CYLINDERS OF PURE ABSORBER. Kalashnikov, A. G.; Toshinskii, G. I.; Tsurkova, E. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1970. 17p. (In Russian). INIS.

If it is possible to select a burnup absorber with a sufficiently high rate of burnup, then spacing of this absorber in the form of cylinders with large diameters appears to be the most efficient. A method for accurate calculation of burnup of cylindrical rods of depleted absorber containing pure absorber under the influence of a known incident neutron flux is presented. A computer program for calculating cadmium and gadolinium rods is briefly described. The results from such a program may be used for testing various burnup models in reactor calculations. (tr-auth) (INIS)

4068 (ORNL-tr–2527) PICFEE: PROGRAM FOR THE INTEGRATION OF ELEMENTARY FISSION CURVES WITH CONSIDERATION OF THE DEVELOPMENT OF FISSILE NUCLIDES. Barre, Bertrand (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report CEA-N–1203. 29p. Dep. NTIS.

The PICFEE program permits a calculation of the variation of any quantity which was instantaneously proportional to the number of fissions per unit time in the period following irradiation for a fuel consisting of the fissile elements ^{235}U, ^{238}U and ^{239}Pu (for example, residual power, etc.). Irradiation is defined by a succession of linear power diagrams separated or not separated by zero-power levels, and the curve of the variation of the quantity considered in the time following a fission is integrated over these levels ("elementary fission" curve). PICFEE can take into account the change of the fuel during irradiation. (auth)

4069 (SRD-R–1) PRINCIPLES OF RELIABILITY FOR NUCLEAR REACTOR CONTROL AND INSTRUMENTATION SYSTEMS. Eames, A. R. (United Kingdom Atomic Energy Authority, Risley (England). Safety and Reliability Directorate). Sep 1971. 11p. Dep. NTIS (U. S. Sales Only).

A number of reliability principles for safe and economic nuclear reactor operation are presented. Some basic precepts are specified and these are followed by discussions of system design, equipment, controls, sensors, wiring, maintenance and human factors. For each of these, a number of reliability principles are stated with a view to meeting the basic precepts. (auth)

4070 DEVICE FOR REGULATING FLOW. (to Societe Grenobloise d'Etudes et d'Applications Hydrauliques). French Patent 2,044,340. 8 Feb 1971. Filed 23 May 1969. (In French).

Equipment for controlling the circulation of the coolant in the interchangeable tubular elements of a reactor is described. A common source feeds the tubular elements from their bases; the fluid flow in each element is, however, dependent upon its position on the support. One or several diaphragms are used to produce the different pressure drops in the various housings. An annular space is provided between the foot of the tubular element and its housing; each diaphragm consists of a collar external to the foot of the element and a collar inside the housing. The feet of all the tubular elements are identical, but the dimensions of each diaphragm and the positions of the fluid input orifices may vary from one housing to another. (France)

4071 IMPROVEMENTS TO HEAT PRODUCTION BY A NUCLEAR REACTOR. Coste, Philippe. French Patent 2,052,119. 29 Mar 1971. Filed 18 Jul 1969. (In French).

A process of heat production using a heterogeneous reactor with a liquid moderator and application facilities is presented. The heat exchanger is outside the reactor which has a fixed core partially immersed in the liquid moderator. This liquid phase circulates as a transfer liquid. The same phase communicates with the liquid phase of a second vessel containing also a vapor phase and working at a pressure (or a temperature) different from that of the vessel containing the core. The moderator taken from the reactor vessel is reintroduced in this vessel after cooling by heat exchange. The flow rate of the moderator reintroduced is adjusted in function of the amount of heat to be transmitted. (France)

4072 SEALING DEVICE FOR THE ROTATING PLUG OF A NUCLEAR REACTOR. Lepert, Claude; Sauvage, Michel (to Commissariat a l'Energie Atomique). French Patent 2,045,605. 5 Mar 1971. Filed 6 Jun 1969. (In French).

A sealing device for the rotating closure plug of a reactor vessel is presented. The plug is extended by a peripheral ring bearing on supporting and lifting structures. The sealing device consists of a skirt coaxial to the ring and rigidly locked to it, of static seals (between the skirt and the vessel), and of a dynamical seal outside the skirt. (France)

4073 BRAKE SYSTEM. Jug, Victor; Tortel, Jean (to Commissariat a l'Energie Atomique). French Patent 1,459,145. 15 Feb 1971. Filed 4 Jul 1968. 1st Addition 95,560. (In French).

A system for braking a moving mass especially intended for braking the scram rods during their drop in a nuclear reactor core is described. The device consists of a stem for guiding the dropping mass made of two parts of different diameters. The first part enables the mass to slide free along the stem, the second part enables the braking. (France)

4074 REACTOR CORE WITH REMOVABLE CORE ELEMENTS. Paget, John A. (to United States Atomic Energy Commission). U. S. Patent 3,607,643. 21 Sep 1971. Filed 4 Apr 1969.

In the top layer of a lattice of core elements, keys interlock the core elements and provide geometric stability for a reactor core. The core elements are interlocked by loose, shared keys extending between keyways in a pair of adjacent core elements. These loose shared keys are readily slideable from the keyways with removal of either of the core elements whereby the cavity is left clear to receive new replacement core elements. Fixed keys may also be attached to the core elements to facilitate alignment and keying of core elements to each other. (auth)

4075 REACTOR CORE RADIAL LOCKING DEVICE. Stankiewicz, Raymond S. (to United States Atomic Energy Commission). U. S. Patent 3,607,645. 21 Sep 1971. Filed 2 Jul 1968.

A nuclear reactor core-locking device is described which holds the fuel assembly loosely for refueling and tightly against vibration or other adverse movement under operating conditions. A

core-retainer band surrounds and is spaced from the core at assembly. The retainer band is made from material having a lower coefficient of thermal expansion than the core structural material so that when operating temperatures are reached the core expands into contact with the band and becomes effectively locked into place. (auth)

4076 FUEL ELEMENT VENTING SYSTEM. Seim, Orville S. (to United States Atomic Energy Commission). U. S. Patent 3,607,638. 21 Sep 1971. Filed 8 Apr 1970.

A fuel element for a nuclear reactor includes a vent permitting release of gaseous fission products to the coolant during operation of the reactor while ensuring that the fuel material is sealed within the fuel element. This is accomplished with a valve member such as a ball or needle of low coefficient of thermal expansion disposed within a passageway in an end cap for the fuel element which is formed of a material having a high coefficient of thermal expansion. At low temperatures the vent is sealed by the ball or needle, at high temperatures it is open so that fission gases can pass through. (auth)

4077 FUEL ASSEMBLY FOR NUCLEAR REACTORS. Van Santen, Aart; Samskog, Lars-Erik; Tornblom, Lars (to Allmanna Svenska Elektriska Aktiebolaget). U. S. Patent 3,607,639. 21 Sep 1971. Priority date 17 Jul 1967, Sweden.

A fuel assembly for nuclear reactors is formed of a plurality of substantially parallel fuel rods arranged between a top plate and a bottom member inside a sheathing tube. Spacer elements for these tubes are provided with leaf springs secured to the spacer frames, the free ends of the springs having buttons thereon engaging in holes in the sheathing tube to position the spacer elements in the tube. (auth)

4078 PERIMETER STRIP FOR A NUCLEAR REACTOR FUEL ASSEMBLY SUPPORT GRID. Krawiec, Donald M. (to Combustion Engineering, Inc.). U. S. Patent 3,607,640. 21 Sep 1971. Filed 24 Jun 1968.

A perimeter strip for a nuclear reactor fuel assembly support grid is described. The perimeter strip forms the outer edge of an egg-crate-type fuel-rod-spacing grid and is rigidly welded to the strips passing intermediate the fuel rods. It comprises a central portion parallel to the fuel rods and spaced therefrom as well as upper and lower portions parallel to the fuel rods at a location inwardly of the central portion. Sloping portions of the strip join the central portion and the upper and lower portions, with the distance between the outer surface of the outer fuel rods and the outer surface of the upper and lower portions being less than the distance between the outer surface of the central portion. The upper and lower portions are arched inwardly slightly to contact alternate fuel rods, while the end portion is formed to make resilient spring contact with the intermediate fuel rods. The sloped portion has holes therethrough adjacent the arches where rigid contact is made with the fuel rods. The egg crate structure is welded to the perimeter strip intermediate the arches and springs only at the upper and lower portions. (auth)

4079 LIQUID-SAFETY-ROD SYSTEM WITH A FLEXIBLE DIAPHRAGM ACCUMULATOR. Agazzi, Alberto; Broggi, Armando; De Paratsei, Sergio Galli; Ghiurghi, Luciano (to EURATOM). U. S. Patent 3,607,644. 21 Sep 1971. Priority date 26 Oct 1967, Belgium.

A liquid-safety-rod system for nuclear reactors is described which consists of a lower poison-solution reservoir, a poison-solution accumulator containing a flexible diaphragm connected therewith, a source of high-pressure gas to force the poison solution out of the accumulator into a connecting collector and thence into tubes extending through the reactor core and a washing circuit comprising a washing-liquid reservoir, a washing-residue reservoir and a pump connected to the tubes. (auth)

4080 INSTALLATION FOR THE REARRANGEMENT OF FUEL RODS AND FUEL IN A NUCLEAR REACTOR. Vrillon, Bernard (to Commissariat a l'Energie Atomique). French Patent 2,044,649. 26 Feb 1971. Filed 12 May 1969. (In French).

The installation contains fuel rod container tubes having slits along their lengths; they are arranged vertically in a sealed enclosure and around a rotating part which supports a transfer tube, also possessing a slit. A lifting device, which moves vertically along one of these tubes and the transfer tube, possesses a mobile part for releasing the fuel element, which is to be moved, and a means of supporting the fuel rod. The apparatus includes a means of spraying the cooling fluid in the upper part of the enclosure and a means of evacuating the fluid from the lower part of the enclosure. (France)

4081 CONTROL ROD FOR A NUCLEAR REACTOR. Pflucrad, Kurt; Sicard, Bruno (to Commissariat a l'Energie Atomique). French Patent 2,041,723. 5 Feb 1971. Filed 13 May 1969. (In French).

The invention is related to the control rods used in nuclear reactors and the safety rods intended to be dropped in case of an incident and rapid shutdown of the reactor. The control rod which is described has a high mean density and a satisfactory neutron absorption. The absorption is obtained by using at least two materials. The light material is a boron compound (boron carbide for instance) absorbing neutrons by the (n,α) reaction. The second material is of a type undergoing an (n,γ) reaction and its density is higher than that of the boron compound. The second material may be Ta, which has the advantage of a high thermal conductivity and a fusion point higher than that of boron carbide. The tantalum may be placed at the end of the rod which reaches the highest temperature when inserted into the core. (France)

4082 THERMAL PROTECTION DEVICE FOR A NUCLEAR REACTOR VESSEL. Schaller, Karl; Costes, Didier; Delisle, Jean-Paul; Gallo, Sabino (to Commissariat a l'Energie Atomique). French Patent 2,044,625. 26 Feb 1971. Filed 10 Mar 1969. (In French).

A thermal protection device for the roof and sides of a fast neutron reactor vessel was developed; the reactor is cooled by liquid sodium, the temperature of which varies very rapidly. The device consists of an enclosed space filled with liquid Na, which is circulated by a pumping circuit, withdrawing the sodium from the coldest region of the space and sending it into the warmest region. (France)

4083 NUCLEAR REACTOR FUELLING INSTALLATIONS. Phillips, Ronald William; Ebeling, Douglas Roy; Todd, William Thomas (to United Kingdom Atomic Energy Authority). British Patent 1,248,932. 6 Oct 1971. Filed 3 May 1968.

Reference is made to installations for fuelling liquid cooled reactors while operating under pressure. Conventional on-load fuelling facilities necessitate complex and very expensive equipment. In the system described, a pond of the coolant surmounts the reactor and the fuelling facility dips into the pond. The fuelling facility is floodable from the pond, and is sealably connectable with the reactor coolant circuit for transfer of fuel between the facility and the reactor, being traversable in the pond with the contained fuel submerged in the liquid in the pond. The liquid both inside and outside the facility provides shielding for personnel working above the pond. Pressurized coolant from the reactor can be used to raise the level of liquid in the facility to increase radiation protection, and fission product decay heat is transferred to the pond through the liquid in the facility. The system affords relatively simple and inexpensive construction and complex coolant circuitry is avoided. The method of operation is described in detail. (UK)

4084 IMPROVEMENTS IN CONTAINMENT VESSELS OF CONCRETE. Fagence, Graham Paul (to Babcock and Wilcox Ltd.). British Patent 1,247,869. 29 Sep 1971. Filed 16 May 1968.

Reference is made to concrete pressure vessels such as are used as containment vessels and biological shields of nuclear reactors, and in particular to cavity closure means. The closure means described comprise an annular plate having a cover that clamps the plate in position by the use of pre-stressing tendons existing on the plate, a force acting in the opposite sense to that which would be exerted on the closure means by superatmospheric pressure in the vessel. The plate may be in the form of a flange extending outwardly from a sleeve that projects into the opening and that is provided with a radially inwardly projecting flange, the cover being connected to the latter flange. (UK)

4085 NUCLEAR REACTOR CONTROL ELEMENT GRIPPER AND DRIVE APPARATUS. Notari, Gennaro Vincent (to Combustion Engineering Inc.). U. S. Patent 3,604,746. 14 Sep 1971. Filed 20 Nov 1968.

An apparatus is described for gripping, driving, and disconnecting control elements in a nuclear reactor having grippers mounted on an elongated support tube and gripper operators mounted on an elongated rod extending through the support tube and movable longitudinally therein to operate the grippers. The support tube is suspended from its upper end on a control element drive means by a nut and nut-locking mechanism. Unlocking and rotating the nut raises and lowers the support tube and grippers between an operating position and a disconnecting position and raising and lowering the rod within the tube operates the grippers. A plurality of control elements may be connected to a single drive assembly. (Official Gazette)

4086 NUCLEAR REACTOR FUEL ELEMENT CLUSTERS AND ASSEMBLIES. Lewis, Robert Alec; Binns, Ian Mason (to United Kingdom Atomic Energy Authority). British Patent 1,248,737. 6 Oct 1971. Filed 1 Mar 1968.

In the construction described an object is to provide a fuel element assembly having stacked clusters, with a central duct for emergency cooling water, the clusters being demountably connected in a continuous chain to facilitate insertion in, or withdrawal from, the reactor. The use of tie-bars, with their attendant disadvantages, is avoided. Each cluster has a resiliently deformable latch member extending coaxially from one end and a nondeformable latch member at the opposite end; each latch member telescopically engages a corresponding opposite member of an endwise adjacent similar cluster, whereby adjacent engaged clusters are movable into and out of end abutment. The latch members have annular hooked lips for locking engagement with the corresponding opposite members of endwise adjacent clusters when the clusters are telescoped apart. A central perforated tube is provided for demountable connection with the similar tube of an endwise adjacent cluster to give a continuous duct along the axis of the assembly. At least three of the fuel elements may have sheaths of greater thickness than the remaining elements, these thicker sheaths serving as struts to support compressive loads on the cluster. (UK)

4087 BURNUP DETERMINATION OF FUEL THROUGH IRREVERSIBLE FLUENCE MONITORING WITH COBALT. Muench, E. (Kernforschungsanlage, Juelich, Ger.). Atomwirt., Atomtech.; 16: No. 10, 530-1(Oct 1971). (In German).

To measure burnup, 5 volume % of ^{59}Co was added to the ^{235}U of fuel elements. Following irradiation, the ^{60}Co γ lines could be measured with a high resolution Ge(Li) detector. When applied three days following cessation of irradiation, the method yielded the degree of burnup within 1 min of measuring time, even without knowledge of the radiation history. (H.B.G.)

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